



THE **new** FUNK & WAGNALLS

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ENCYCLOPEDIA

VOLUME
SQU-TAR

21



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SQU-TAR **21**



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Portions of this work have also been published as The International Wildlife Encyclopedia,
Encyclopedia of Animal Life, and Funk & Wagnalls Wildlife Encyclopedia.

Funk & Wagnalls

DB a company of
The Dun & Bradstreet Corporation



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Cover Photo: Ibex
Hans Reinhard—Bruce Coleman Ltd.

Frontispiece: Barn Swallow
Stephen Dalton—Bruce Coleman Ltd.

ISBN 0-8343-0035-4
Library of Congress Catalog Card Number 80-66926

Printed in the United States of America

Volume 21

Squat lobster

The four species of squat lobsters look like small lobsters but are more nearly related to hermit crabs. The body is stout and more flattened than in a true lobster and the broad abdomen is tucked under it. The antennae are long and slender, with a slightly stalked eye near the base of each. The long claws are strong and pointed, and the four pairs of legs all lack small pincers. Three pairs are used for walking, but the fourth pair is very small and weak and is usually tucked away out of sight. The largest *Galathea strigosa* is not more than 6 in. long in the body, and it is one of the more handsome crustaceans, being red marked with blue lines and dots. The claws and legs and the sides of the body bear numerous spines. The smallest *G. intermedia*, only 1 in. long including the claws, is also red marked with blue. Of the other two, both about 2 in. long,

one *G. dispersa* is dull red, sometimes with pale markings, and the other *G. squamifera* is greenish-brown with red flecks.

All four species are European. The commonest *G. squamifera* is the dullest in colour and is the one most often found between tidemarks. The others are not common and live well down the shore, usually in shallow offshore waters.

Poor swimmers

Squat lobsters are crawlers but they can swim; they can dart backwards by stretching the abdomen backwards, and suddenly flicking it forwards. Whereas a lobster when alarmed will swim backwards for long distances, by alternately stretching and bending its abdomen, a squat lobster will not swim far but will try to crawl under the cover of rocks and pebbles. So, in its habits and in its structure, it represents an inter-

mediate stage between the active true lobsters and crabs and the more sedentary hermit crabs. Squat lobsters are not difficult to find on rocky shores, especially in spring and summer, under large, flat stones. Their usual reaction on being discovered is to creep backwards, trying if possible to crawl away out of sight. The largest of them will try to use its claws in self-defence, but apart from this squat lobsters seem to lack the aggressive disposition characteristic of the true lobsters and crabs.

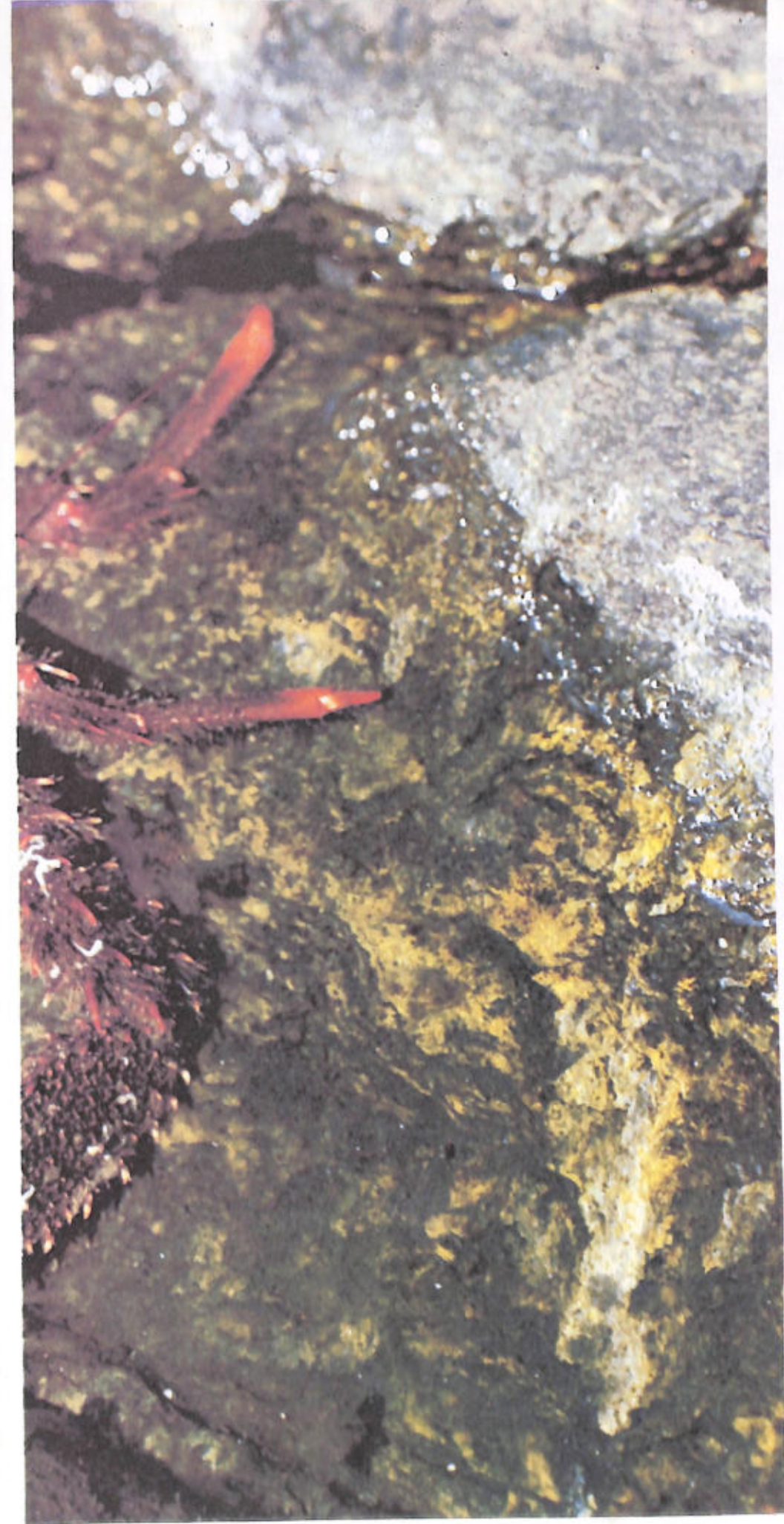
Particulate feeders

They can also be said to be intermediate in regard to their feeding habits. The larger of them will eat pieces of meat, when in aquaria, but this is unusual as they have lost the predatory habits typical of the larger crustaceans. Their usual food is made up chiefly of small particles of animal flesh which are swept into the mouth by a brushing action of the bristles on the mouth parts.

▽ Rock pool setting—an undeterred common squat lobster keeps company with a snakelocks anemone *Anemonia sulcata* and delicate red algae.







Primitive larvae

The life history is similar to that of other large crustaceans but the zoea larvae are more primitive and less highly specialized in their structure than are those of true crabs. They are more like those of shrimps and prawns. At a later stage in the larval life they look like very tiny but incomplete shrimps. The larvae of even the largest squat lobsters are only $\frac{1}{16}$ in. long.

Wayward crustaceans

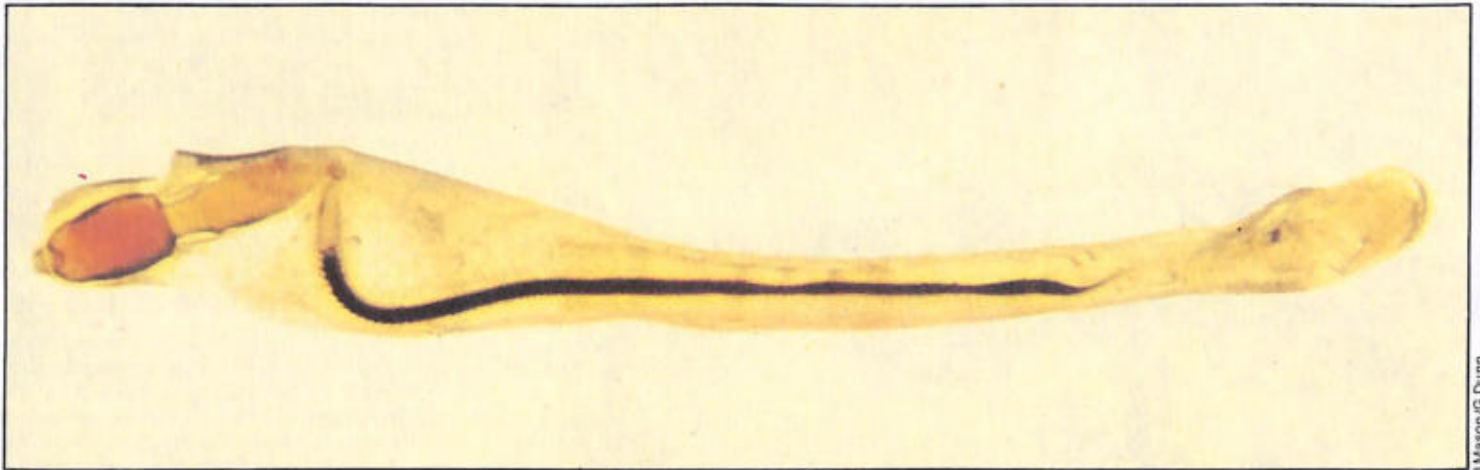
The squat lobsters are not only some of the more fascinating crustaceans to watch; they are important for the light they shed on the relationships of the decapod (10-legged) crustaceans. On the one hand we have the shrimps, prawns, and lobsters, with the long abdomen normally fully extended backwards. On the other hand we have the true crabs with the abdomen small and tucked in under the rest of the body. In between we have the hermit crabs with an asymmetrical abdomen, with the legs much reduced and those on one side of the abdomen missing altogether. So at first sight the hermit crabs, while having quite obviously some relationship with shrimps, prawns, lobsters and crabs, are 'screwy' in shape and have gone off on a line of their own. They have also specialized in sheltering in empty shells.

If we could assemble all the squat lobsters and their relatives together we could build up a series showing how this came about. The abdomen of squat lobsters is slightly asymmetrical. That of the porcelain crab *Porcellana longicornis*, often found under stones in company with squat lobsters, has the abdomen slightly more asymmetrical. With luck we might find another relative nearby, the burrowing prawn *Callinassa subterranea*, which looks like a normal prawn but lives in a burrow in the sand and has one claw much larger than the other, as in hermit crabs. We might also find the stone crab *Lithodes maia*, which is spiny like the squat lobsters, looks like a spider crab, which is a true crab, but has a very asymmetrical abdomen.

The story is repeated with variations on other shores outside Europe. On the North American coasts, for example, there are the porcelain crabs *Pachycheles* and *Petrolisthes*, almost indistinguishable except to the expert eye from the European porcelain crab. There are also stone crabs *Lopholithodes*, sand crabs *Emerita* and mole crabs *Blepharipoda*, so named because they burrow. In these also we could trace the tendency towards asymmetry, the tendency to become particulate feeders rather than predators, the tendency to shelter in crevices, cracks or burrows, that have taken the hermit crab along its own evolutionary path.

phylum	Arthropoda
class	Crustacea
order	Decapoda
suborder	Anomura

◁ The largest squat lobster *Galathea strigosa* is not more than 6 in. long in the body.



J. Mason/G. Dunn

Squid

All squids are marine, and in contrast to their relatives, the octopuses and cuttlefish, they have a streamlined body and are fast swimmers. There are about 350 species, ranging in size from less than an inch to nearly 60 ft. The head bears two well developed eyes, remarkably like our own in structure though independently evolved, eight arms corresponding to those of an octopus, plus two longer tentacles. The body tapers towards the rear, bears lateral fins at the back and contains the remains of the ancestral shell.

The underside of the body contains the mantle cavity into which open the reproductive and excretory organs, the ink sac and the hind end of the digestive tract. Here also are the two gills in which the squid's blue blood is oxygenated. The pulsations of the muscular wall of the mantle cavity continually draw water in and out through a muscular funnel which opens behind the head. The squid, like other cephalopods, utilizes this water current for jet propulsion, shooting it out through the funnel which can be directed forward or back to send the squid rapidly in either direction. The water is sucked in, not through the funnel, but around its base. For the fastest possible response of this system and for the synchronisation of the contraction of the different muscle fibres, rapidly-conducting nerve fibres are essential in linking brain and muscle. The nerve fibres of molluscs lack the covering that facilitates the very rapid conduction of nerve impulses in mammals, but the rate at which nerve fibres can conduct impulses increases with their thickness. Thus squids have evolved enormously thick nerve fibres to link brain and mantle muscle. They are over $\frac{1}{2}$ mm thick as compared with diameters of one thousandth to one fiftieth of a millimetre in humans. Study of these 'giant fibres' has been of immense help in elucidating the way in which nerve impulses are conducted through the body of an animal.



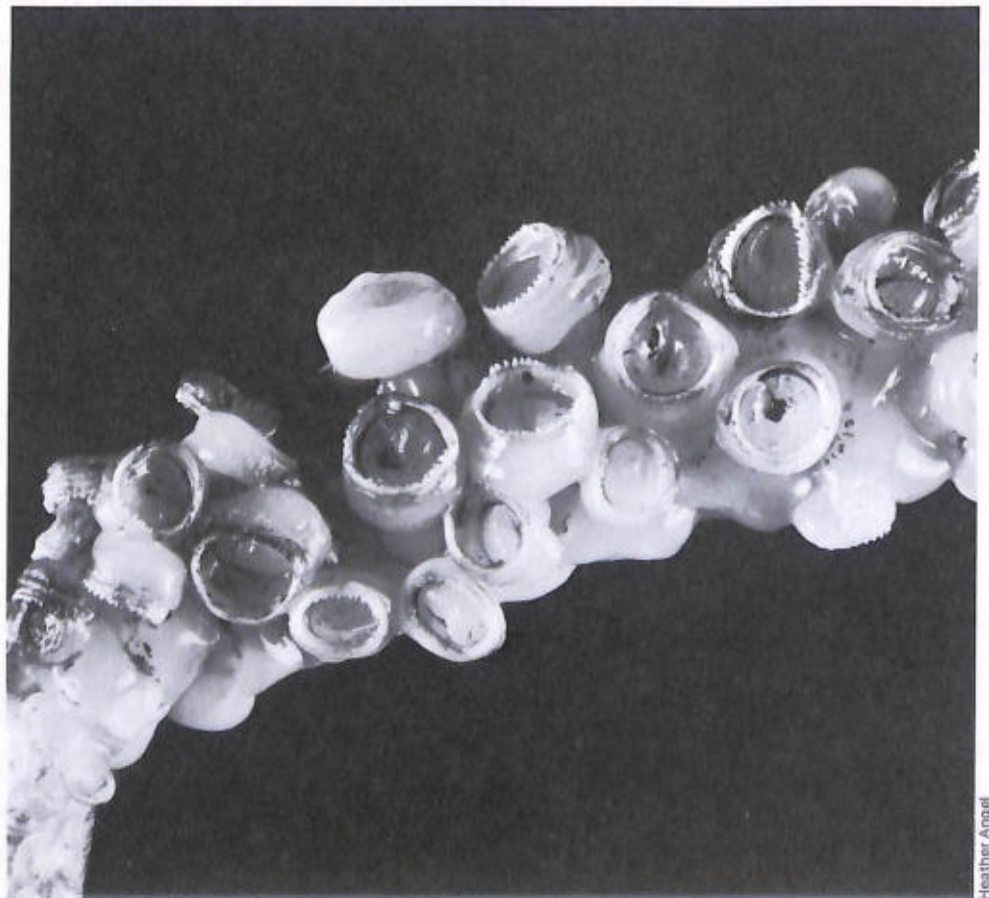
Heather Angel

△ *Loligo spermatophore*, a long torpedo-shaped chitin tube containing spermatozoa. During mating the male transfers bunches of these spermatophores from his mantle cavity to the female's mantle cavity using his specially modified fourth arm (approx $\times 47$).

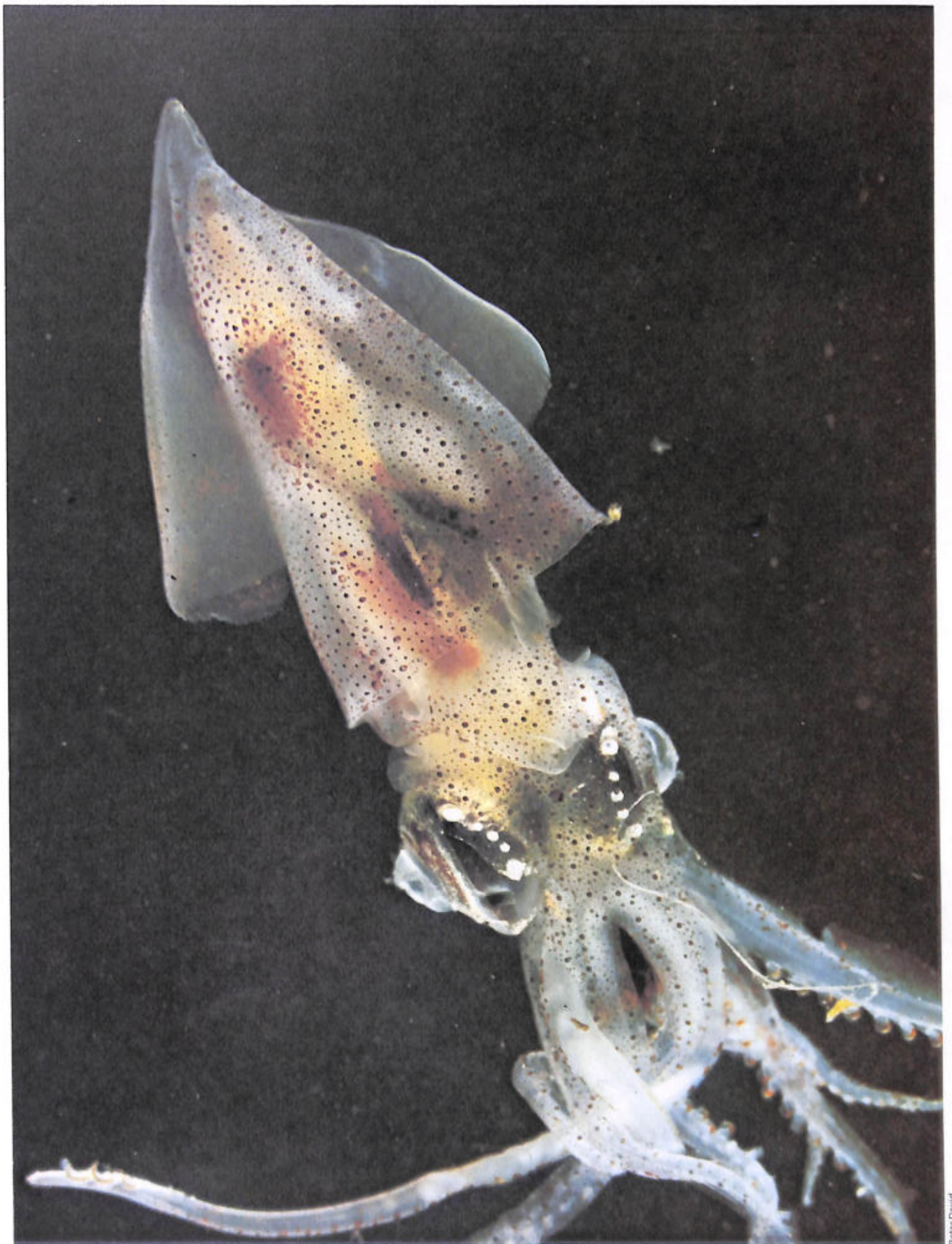
◁ Beak of the squid *Loligo forbesi* removed from the centre of the arms. The mouth's parrot-like beak is sharp enough in some cases to sever thick wires. Squid beaks are often recovered in sperm whale stomachs. They give useful information both on the distribution of squid and the feeding habits of the whales.

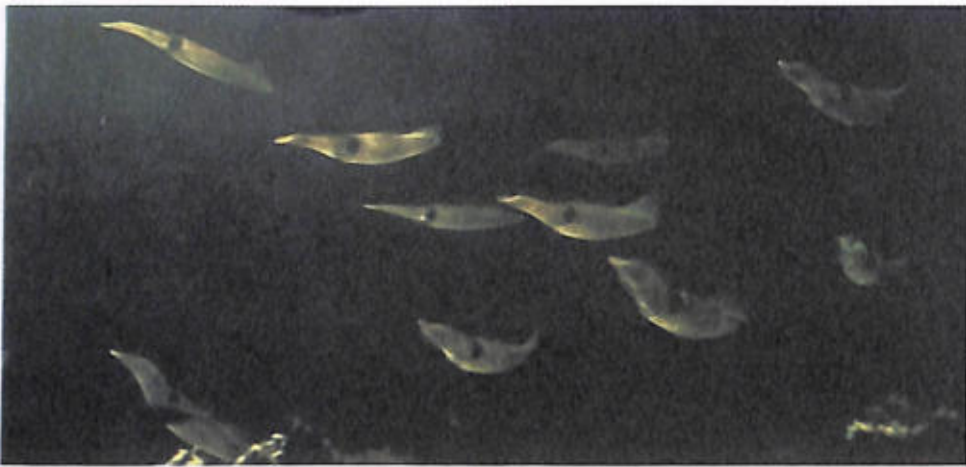
▷ *Abraliopsis* with conspicuous light organs.

▽ Close-up of the suckers of one of the long tentacles of *Loligo forbesi*. The hooked marginal rings to the suckers aid in gripping the prey. Both arms and tentacles bear suckers though some of these, in 'hooked squids', are replaced by hooks.

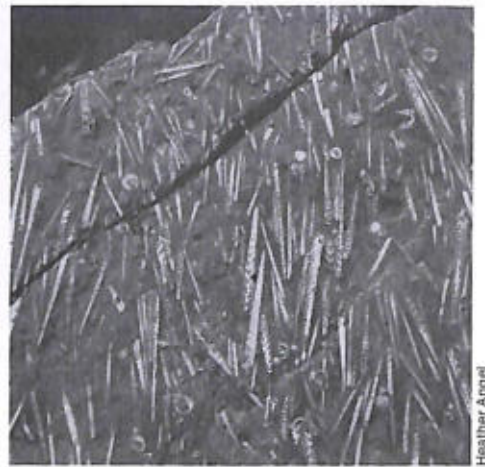


Heather Angel





△ Moving backwards. The tentacles of these squid *Loligo vulgaris* are pointing to the left.



△ Belemnites, fossil record of past squids.

Illuminated squids

Squids tend to move about in shoals, often of one sex only. They can swim well in either direction but travel mostly backwards. Like the octopus (p. 1744), they are masters of colour change and have chromatophores of various colours in the skin that can be contracted and expanded to produce a variety of patterns. *Sthenoteuthis*, for example, has chromatophores of the three primary colours—blue, yellow and red.

One of the best-known species is *Loligo forbesi* of the North Sea, northeast Atlantic and Mediterranean. Large ones may be 2 or 3 ft long, but most range from 8 to 12 in. Less typical in appearance is the small *Chiroteuthis veranyi* with its long tentacles many times the length of the body, and the reddish-purple to black *Histioteuthis* with six of its arms joined by a membranous web whose jellyfish-like movements largely replace the use of the funnel in swimming. In *Bathothauma*, a small deepsea squid, the arms are very short and are carried in a small rosette around the mouth on the tip of a long peduncle and the eyes are on long stalks. *Calliteuthis* also has unusual eyes in that one is much bigger than the other. The small one is surrounded by a cirlet of light-producing organs. Many squids have light organs, especially those living in deep water. The light organs may be on the eyes, on the tentacles, or scattered all over the body. *Histioteuthis bonelliana* a Mediterranean species about a yard long, has nearly two hundred of them. The light organs themselves may be very complex, with reflectors, lenses, diaphragms, colour screens and other accessory structures. Some squids do not themselves produce the light but have luminescent bacteria in their light organs which are transmitted to the next generation in the squid's embryo. The light is sometimes given out from internal organs and shines through a translucent body wall.

The dreaded kraken

The largest squids belong to the genus *Architeuthis*, the biggest one known being a specimen of *A. princeps* stranded on the Newfoundland coast in 1878. Its body was 20 ft long and its total length 55 ft, a length only exceeded by a specimen of the less bulky *A. longimanus*, 57½ ft long, found in Lyall Bay, New Zealand, in 1888. Smaller specimens of *Architeuthis* have been stranded

on the shores of the British Isles. These giant squids, some of which probably exceed even the recorded maximum sizes, are no doubt responsible for the stories of the dreaded Kraken in Norse legend. From their anatomy they are thought not to be powerful swimmers and are believed to live at a depth of 600–1 200 ft.

Prey chased or ambushed

Fish and crustaceans are their main food, as well as smaller squids. Once seized, the prey is quickly paralysed by venom produced by one of the two pairs of salivary glands. *Loligo* seizes a fish behind the head and bites it off with its parrot-like beak; the rest is bitten into small pieces and digestion is completed in 4–6 hours. Squids may chase their prey or make use of their camouflaging abilities to ambush it.

Massive matings

In temperate seas squids generally breed in spring or summer. In *L. peali* of American waters, which is typical, courtship starts with the male displaying to a female with his arms. Coloured spots appear on his arms and he blushes red all over his body from time to time. His sperms are packed into special torpedo-shaped tubes of chitin about ½ in. long, called spermatophores, and he transfers bunches of these elaborate structures to the female by means of his left fourth arm which is specially modified for the purpose. Before doing so, he lies parallel to his mate, lower side to lower side and with his arms around her, just behind the head. He then takes some spermatophores from his own mantle cavity and places them in hers. Alternatively, the pair may join head to head, in which case the sperm packets are deposited on a glandular patch amongst the female's tentacles. The eggs are laid in strings of jelly material which become attached to the sea bed. *Loligo* seems to die after spawning. Courtship is a communal activity in squids and great shoals may gather for the purpose, sometimes then migrating inshore to breed. The number of eggs produced by a shoal may be colossal, though the egg masses of 40 ft or more across, reported off California in 1953 were exceptional. In 1955 it was estimated that in this locality the eggs covered 200 acres of seabed. The young hatch as recognizable squid-like forms.

Smoke screens save sometimes

Squids are too nimble to be netted in large numbers, except when they are gathered in mating shoals, but they are nevertheless not without enemies. They are eaten by petrels, albatrosses and other sea-birds and they are the main food of the king penguin. The emperor penguin also eats them in large numbers as do also seals, sea lions, elephant seals, toothed whales and tunny fish. For escape squids rely partly on their agility and excellent vision, but also on their ability to change colour and to blow ink out through the funnel. The ink may be used simply as a smoke screen, but in some species it remains for a while as a compact cloud in the water, roughly the size and shape of the squid producing it. As this decoy is formed, the squid darts off backwards, changing to a different and less conspicuous colour as it does so. The predator, presumably, tries to seize the blob of ink and loses sight of the squid itself.

Flying squids

There are at least two kinds of flying squids. Of these, *Onychoteuthis banksi* occurs in all oceans and is sometimes stranded on the shore. Its fins are wide and additional planes are provided by broad membranes on the arms. It was the account of the Kon-Tiki expedition that brought 'flying squids' to general attention, though they had long been known to sailors because they not uncommonly landed on the decks of ships. These extraordinary animals are hooked-squids that can leave the water with such velocity that they may sail 50–60 yd through the air before re-entering the sea. They sometimes leap singly, sometimes in twos or threes. They have been known to hit ships as high as 20 ft above the waterline. This habit is probably a means of escape from predators.

phylum	Mollusca
class	Cephalopoda
order	Teuthoidea
families	Architeuthidae Histioteuthidae Chiroteuthidae

Squirrelfish

Squirrelfishes are usually bright red and they have large eyes, giving them a faint resemblance to red squirrels, and this seems to be the only reason why they were given their common name. They have deep bodies compressed from side to side, large heads, strong jaws and large eyes. The largest is 2 ft long but 1 ft is a more usual length. Their scales are large with sharp points on their hind edges. There are sharp spines on the head and on the gill covers. The front half of the dorsal fin is spiny, the rear half tall and soft rayed. The anal fin has four spines in front, the middle one large. The large pelvic fins are situated forward on the body and level with the pectoral fins. The tailfin is forked. The red body is usually ornamented with silvery spots or stripes on the flanks, running from behind the gills to the base of the tailfin. One of the most widespread in the Indo-Pacific, the red soldierfish, lives in deeper water than most, down to 90 ft. It is bright red and each row of scales along its body bears a silvery stripe. Its fins are rosy with black markings.

There are 70 species in tropical seas throughout the world, most of them living in shallow water.

Unneighbourly fishes

Most squirrelfishes are nocturnal. By day they shelter singly in crevices and cracks in the coral. Each occupies a territory and shows a marked territorial behaviour. Some members of a related genus *Myripristis* contrast with typical squirrelfishes in sometimes forming shoals. Squirrelfishes are also noted for the noises they make, which are loud enough to be heard above the water. These are produced by the vibration of muscles attached to the swimbladder, which acts as a resonator. The sounds are used, it seems, for the same basic purpose as birdsong, to advertise the occupation of a territory and to bring pairs together for breeding. Their territorial instinct was made use of off the Hawaiian islands in fishing for squirrelfishes, which are an important food fish. A squirrelfish was caught, using a net, then a string was tied round the live fish which was put back into the water and dangled near the crevices in the rocks. The other fishes soon came out to fight it and, by drawing the captive fish gently to the surface, these could easily be caught by carefully lowering a net under them.

Prickly owls

Apart from their colour and the size of their eyes squirrelfishes are remembered because they are prickly to handle. They are also notable for their nocturnal habits, which are linked with the large size of their eyes. Indeed, they could more appropriately have been called owl fishes, except that the name squirrelfish was given them in the early 18th century when people were less interested in animal behaviour and more apt to give a name based upon

general appearance. This, presumably, is what led to one species being called the wistful squirrelfish.

Staking out claims

They are predatory, catching smaller fishes, and one reason for their pronounced territorial instinct is that it keeps the individuals well spaced out, so avoiding competition with each other. This is probably when they use their sounds, to warn possible trespassers off their beat.

Helpless larvae

The connection between the sounds they produce and their breeding was first discovered by accident when squirrelfishes were in a display tank in a television studio in America. During the rehearsal the sounds

were heard and a pair of squirrelfishes were seen to be courting, lying side by side with their tails pressed together and their bodies forming a V. From the eggs hatch larvae remarkable for their long pointed noses. The larvae swim to the surface and become part of the plankton. The larvae are dispersed by currents.

Hazards of infancy

Their nocturnal habits, spininess and their tendency to keep hidden probably means that squirrelfishes have relatively few enemies. The main dangers to the adults, especially those species which have fewer spines than average, is of being caught for human consumption. The chief dangers are in the larval stage when they are eaten in large numbers by tuna fishes.

▽ In close formation, a small shoal of squirrelfishes *Myripristis* in the Red Sea, 20 ft down.



Lights to their eyes

Squirrelfishes are said to be primitive because of certain details in their anatomy. They also form a link between the large multitude of perchlike fishes living today and certain kinds of fishes that were dominant during the Cretaceous period 135-70 million years ago, which had spiny rays on their fins. Even more primitive are the alfonosinos of the family Berycidae. These are also brightly coloured but differ in having a short rounded body and a long, fairly slender tail end. They also differ in living in deep water, at about 2000 ft. The commonest species is the 2ft long *Beryx splendens* which is worldwide in warm seas and is fished commercially.

Another relative is the pinecone fish *Monocentris japonicus* of the family Monocentridae, only a few inches long, which has platelike spiny scales and lives in deep water in the tropical Indo-Pacific. It is eaten in Japan. The only other species in the family lives in Australian waters. It is *Monocentris glorie-maris* (the glory of the sea—which shows what a beauty it is!). These not only have large wistful eyes but have two light organs under the lower jaw—pockets filled with luminescent bacteria.

Strangest of all are the related lantern-eyed fishes of the family Anomalopidae. None is more than a foot long. They also have large eyes with a light organ beneath each eye made up of tubes of luminous bacteria. The fish cannot control the light from the bacteria but they can cover it. Some species do this by drawing a blind—a kind of eyelid—over the light organ. In other species there is a muscle which turns the light organ round so its light is no longer visible from outside.

class	Osteichthyes
order	Beryciformes
family	Holocentridae
genera	<i>Holocentrus rubrum</i>
& species	<i>soldierfish</i> <i>Holotrachys lima</i> <i>wistful squirrelfish</i> <i>others</i>

▷ *Wide eyes, sharp spines and bright colours—characteristics of all squirrelfishes; the Hawaiian striped squirrelfish *Adioryx xantherythrus* is no exception. Squirrelfishes are usually some shade of red but this species also sports candy stripes that look like strings of pearls. In comparison with *Myripristis* a schooling species (illustrated on the previous page) *Adioryx* is a more solitary species and shows a strong territorial pattern. The Hawaiian striped squirrelfish is particularly renowned in that it was the first squirrelfish in which prenuptial activity was observed. A pair will hold their tails together, their heads apart, so that a V or Y is formed between them.*

H Hansen







Squirrel monkey

The small, slender South American squirrel monkey, with its small, almost human, white face and large dark eyes is known in German as Totenkopffaffe, or death's-head monkey. It has long thin hindlegs, rather shorter arms, and a short body. The head is rounded with a small face, and slightly protruding black muzzle. The nostrils, as in all South American monkeys, face sideways. The ears are rather pointed, with long white hairs directed out to the side. The tail is not prehensile, but tends to be held in a coiled position and often partly curls round something as a support. The tail is 16 in. long; the body is only 10 in. Squirrel monkeys have short, usually greenish fur, the top of the head being blue-black. All squirrel monkeys probably belong to a single species, although there is conspicuous variation in colour from one place to another. The Central American form has a jet black

cap and the greenish colour of the body is overlaid with red, while two South American types, from Brazil and Peru respectively, are characterised as the 'Gothic' and 'Roman' squirrel monkeys, because the white arches above the eyes are said to resemble those particular architectural features!

In Central America, squirrel monkeys are found along the coastal strip on the Pacific side of the Panama isthmus. The same race extends down the Pacific coast of South America as far south as Ecuador. To the east of the Andes, they inhabit the tropical forest belt and much of the subtropical forest, extending from the Orinoco river, south across the Amazon, to the Mato Grosso region of Brazil, and possibly past the Llanos de Guarayos.

Loosely organised troops

Squirrel monkeys live in very large bands kept together by the females which lead the troop's movements and form a focus for the young and for the adult males. The males keep somewhat to the edges of the troop, having little to do with each other or the

rest of the troop except in the mating season. Mutual grooming is very infrequent, and although some females are more influential than others, there is no marked hierarchy among them. There is more among the males but because of the low level of social organisation this is not really apparent except in the breeding season.

Squirrel monkeys are said to inhabit forest edge habitats and gallery forest, bordering large rivers, rather than closed primary jungle. They are very versatile ecologically, coming down to the ground and going up to the very tops of the trees. Their food consists of fruit, buds and insects, with little or no leaf matter. The tail, wrapped round a branch, is used as a stabiliser when feeding. It is wrapped around the body when a monkey is resting. The monkeys often rest in groups huddled together with their heads between their knees.

Each troop a matriarchy

The breeding season is not sharply defined but is a period of about five months during which both sexes undergo sexual development. There is a birth peak near the end of the season. The behaviour of all the males changes completely, as does their



Photos by Alan T. Bond



△ Games in the grass. Part of a troop of squirrel monkeys roll about on the ground. They move through the forest in loosely-knit troops of 12–100 individuals, advertising their presence with noisy twitterings.
 △▷ A squirrel monkey, its long tail hanging as a balancer, sits alone in the tree tops.



appearance. They become much fatter in the arms, chest and head. They also become very vocal and highly aggressive, displaying to one another and chasing the females to mate with them. Mating reaches a peak in the dry season, and the young are born 170–180 days later, at the height of the rains. When a female is giving birth the others crowd round and watch the proceedings intently. The baby may be carried around by either male or female, but the male's interest is short-lived and the only thing that keeps him near the troop is the presence of the females. The baby can grip its mother's fur and stay clinging to her, even when it is asleep. Squirrel monkeys breed well in captivity and have been known to live for 21 years.

Discretion the better part

The defenceless squirrel monkey, because of its small size, falls easy prey to small cats, birds of prey, pythons and man. Their only defence is in flight. When one monkey gives an alarm call, the whole twittering troop falls silent. The males go to investigate the source of the disturbance, then return and lead the troop in the opposite direction away from any impending danger.

Monkey language

Many studies of squirrel monkeys' behaviour have been made. One group of scientists has concentrated on studying their use of sounds. They identified 26 separate calls made up of different combinations of a few basic sounds, known as peep, twit, ha, arr and shriek. Human language is also built up of basic elements, the number differing from one language to another. There are markedly fewer in the languages of the more primitive peoples and it is a reasonable assumption that they were fewer still in races of man long since extinct. So these studies provide one more link between monkeys and man. Another interesting point is that the vocalisations differ slightly as between the Gothic and the Roman types of squirrel monkeys.

class	Mammalia
order	Primates
family	Cebidae
genus & species	<i>Saimiri sciurea</i>

Starfish

No animal is more clearly symbolic of the sea than the starfish or sea star. Artists making drawings of sandy beaches seldom fail to include a starfish, yet a starfish lying on the shore is bound to be dead or dying. Starfishes are found in all seas. The typical form is made up of five arms radiating from a small central body with a toothless mouth on its underside. The number of arms may, however, be from 4 up to 50, and some of the common starfishes that normally have 5 arms may have from 3 to 7: The smallest starfishes are less than $\frac{1}{2}$ in. across, the largest 3 ft. The commonest colours are yellow, orange, pink and red, but there are some starfishes that are grey, blue, green or purple. Some of the smallest, known as starlets or cushion stars, have very short arms, so their outline is pentagonal.

The body wall of a starfish is reinforced

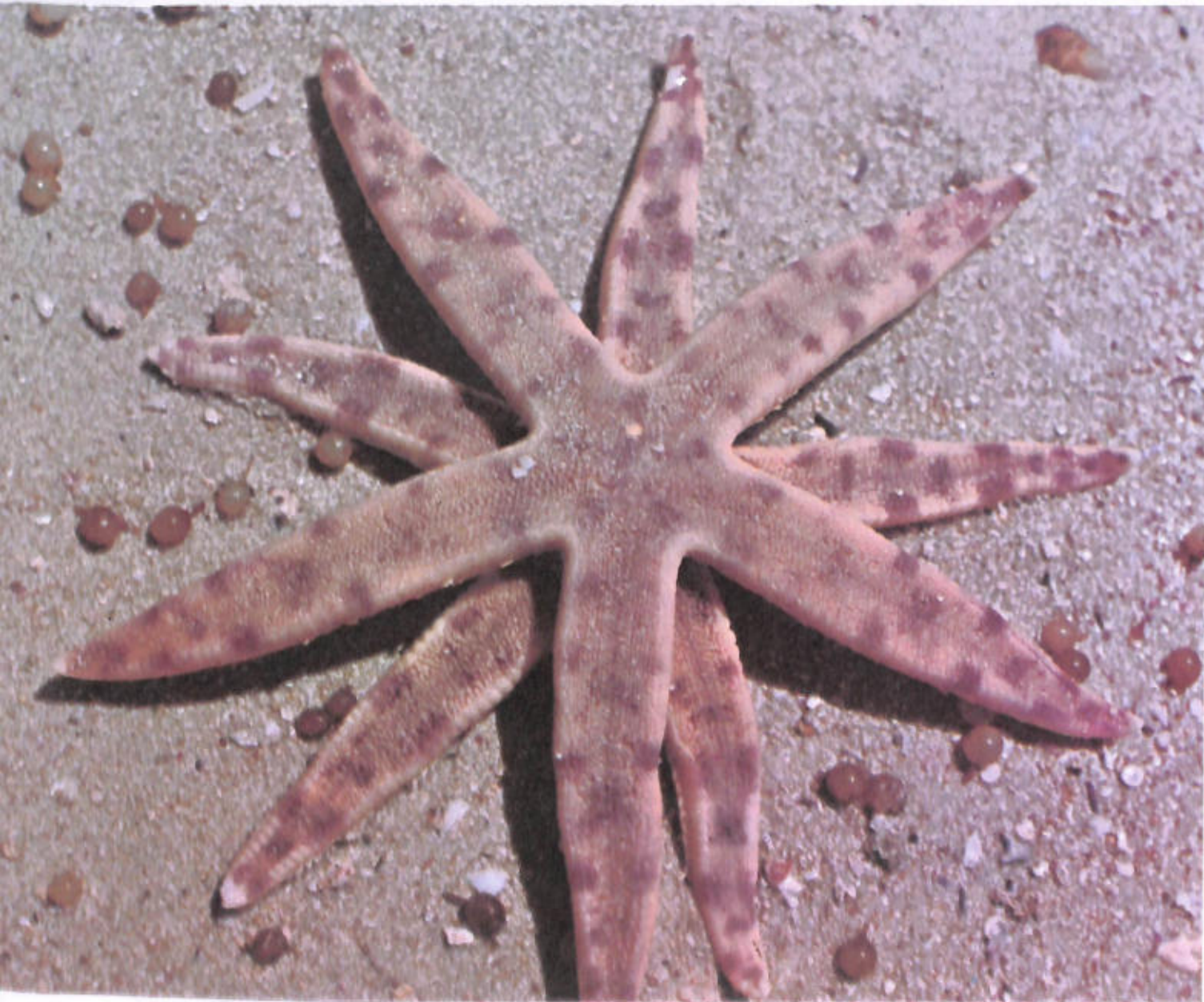
and supported by calcareous plates, or ossicles, more or less exposed at the surface but always with at least a thin covering of skin, although this may wear through in places. They may occur as closely set plates or form an open network. Spines of the same material project from the surface singly or in groups, each spine moved by muscles at its base. The surface may also bear many little pincer-like pedicellariae, like those of sea urchins (p. 2207). The pedicellariae take various forms. Some consist of a pair of tiny jaws mounted on a short stalk while others consist simply of three spines with their bases close together. They play an important part, seizing small organisms, so preventing the surface becoming encrusted with algae and sedentary animals. The pedicellariae are aided by cilia distributed over the surface. The material of the ossicles, spines and pedicellariae of echinoderms is unique in the animal kingdom as each element

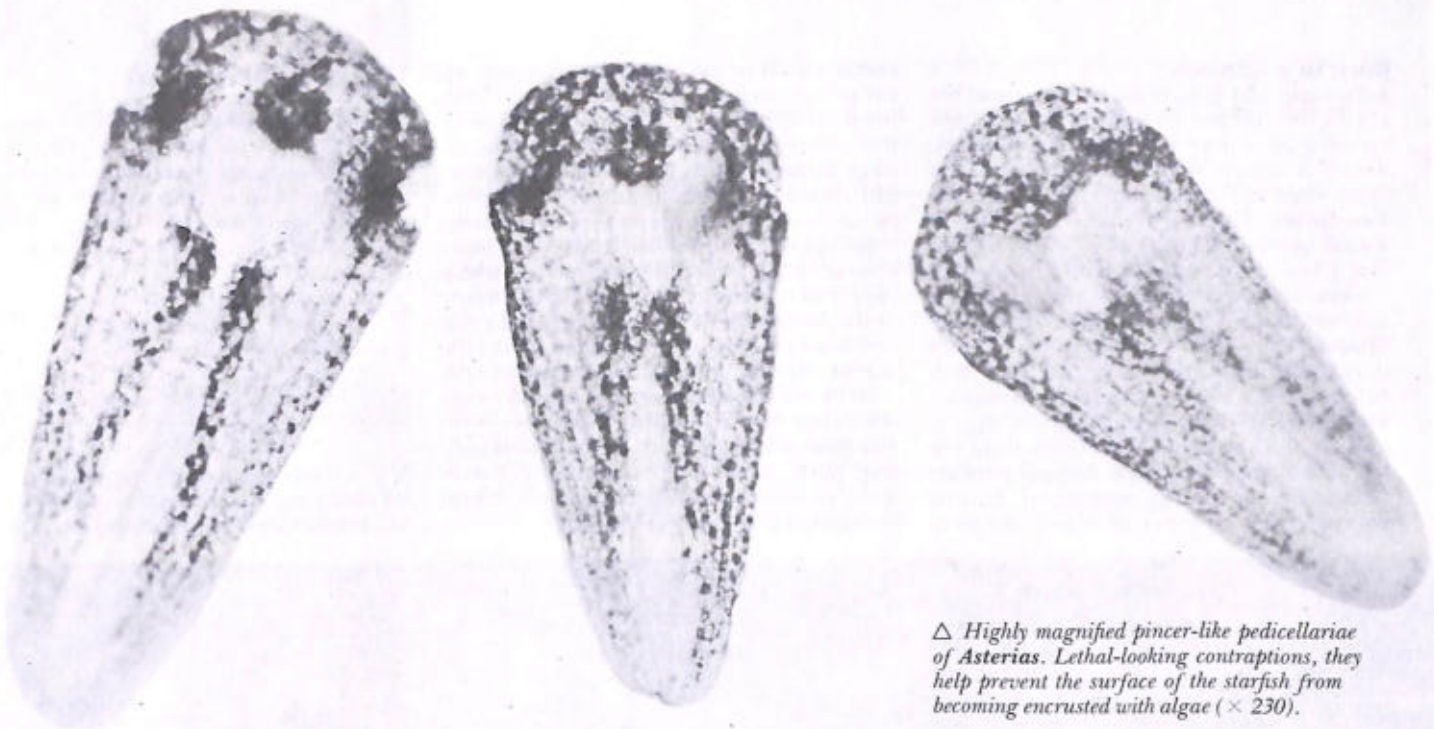
is a single crystal of calcite growing in the form of a three-dimensional network, to combine both lightness and strength.

Besides a general covering of sensory cells there is a light sensitive 'optic cushion' at the base of a short tentacle, which is a modified tube-foot at the tip of each arm.

There are 1 600 species, most of which live in shallow seas but some live in deep seas. The species are most numerous in the northern part of the North Pacific.

▽ Not only rare but also beautifully symmetrical. This starfish *Archaster typicus* is the only one that shows anything approximating to copulation. Other starfishes merely release millions of eggs into the sea during the one breeding season of the year. ▽▷ A starfish can lose all its arms but one and still survive by using its efficient powers of regeneration. The top starfish is regenerating a third arm.





△ Highly magnified pincer-like pedicellariae of *Asterias*. Lethal-looking contraptions, they help prevent the surface of the starfish from becoming encrusted with algae ($\times 230$).

One arm leads the way

Starfish move about by means of numerous tube-feet arranged in two or four rows along a groove on the underside of each arm. The tube-feet are hollow, muscular cylinders connecting at their bases with a system of tubes, the water vascular system which is filled with water. The 'feet' are pushed out hydraulically by the contraction of muscular sacs which lie at intervals along the system of tubes. At their tips there are usually suction discs, which also have sticky secretions which aid them in sticking to rock or prey. In the burrowing starfishes the tube-feet lack suckers. The water vascular system connecting the tube-feet opens to the outside through one or more porous plates on the upper surface. These madreporites, usually single, are situated off-centre of the body disc. In some species one arm nearly always takes the lead when the starfish is walking, but it is more usual for the arms to take turns in leading the way though there are differences in the extent to which each arm is favoured in a given species or individual. One species has been known to travel at the breath-taking speed of two yards a minute, but the more usual speeds are 2–3 in. a minute.

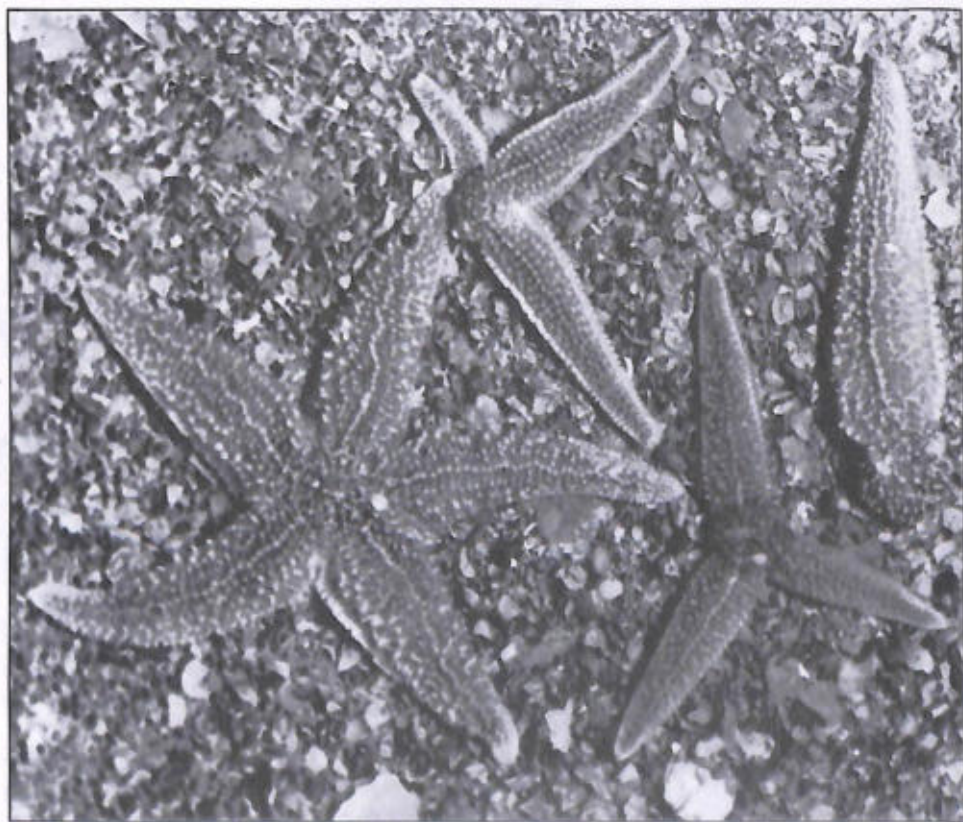
Multiplying by dividing

Irregular starfishes are sometimes found. They are those that have lost one or more arms and are regenerating new ones. Starfish have good powers of regeneration. They are also pests on oyster and mussel beds and those whose job it was to dredge the starfishes to get rid of them used to tear them apart and throw them back. This was a waste of time. The damaged starfishes merely grew from the torn parts, at least part of the body being necessary for regeneration. One genus *Linckia* is, however, known to be able to regenerate just from a piece of arm $\frac{1}{2}$ in. long. *Linckia* actually uses its arms to propagate itself—the arms pulling in two directions till the animal pulls itself in two. Any bits that get broken off add to the numbers of new individuals.

Protrusible stomach

Starfish are generally carnivorous, feeding on molluscs, worms, crustacea, fish and other echinoderms. Those, like *Asterias*, that prey on bivalves open them by arching over them and pulling on the shell valves with their tube-feet. The mollusc may resist for a long time, but the starfish eventually overwhelms it and the bivalve, due to muscle fatigue, has to allow its valves to part a little. The starfish then protrudes its stomach and inserts it inside out into the mollusc—a slit of $\frac{1}{16}$ mm is enough for it to make an entry. The stomach then secretes digestive enzymes into the mollusc. It has been said that the starfish gives out a poison

to make the muscles of the mollusc relax. It now seems there is no firm evidence for this. The burrowing star, *Astropecten*, feeds differently, by taking food in whole. Shells or skeletons are later ejected through the mouth, for this genus has no anus. The cushion star *Porania pulvillus*, sometimes thrown up on the beaches of Europe, is unusual in that it feeds on microscopic organisms, propelling them towards its mouth by means of the cilia on its underside. Another species *Ctenodiscus crispatus* feeds on mud drawn into its mouth in strings of mucus along the grooves under the arms. *Asterina gibbosa*, one of the cushion stars, eats sponges and ascidians.



Born in a stomach

Both male and female starfish have two reproductive organs in each arm, each one opening by a pore at the base of the arm. There is usually one breeding season in a year, when millions of eggs may be released into the sea. *Asterias* may release 2–3 million within two hours, but as many as 200 million are released by some species. In *Asterias*, a bipinnaria larva hatches from the eggs. It has two circlets of cilia and is bilaterally symmetrical. The front end later becomes drawn out into three arms, the larva then being called a brachiolaria, while a curious asymmetrical development results in the growth of a young starfish mainly from the left side of the larva of which it still remains part. After about two months of drifting on currents with other plankton, the larva

anchors itself by its three adhesive arms and the young starfish breaks free from the rest. Some cushion stars attach their eggs to the undersides of stones, the brachiolaria stage being omitted. The change into a starfish therefore occurs at an earlier stage of larval development. Several species brood their eggs and these hatch as young stars instead of as larvae. In these species, which mostly live in colder waters and particularly in the Antarctic, the eggs are large and yolky and less numerous. In some species, like the scarlet starfish *Henricia sanguinolenta*, the mother arches herself over her sticky eggs until they hatch. Meanwhile she goes without food. Amongst other methods of brooding, perhaps the oddest is that of *Leptasterias groenlandica* in which the eggs are kept in pouches in the parent's stomach.

Stars of the Sea

▷ Cutting a swathe through the Pacific coral by eating all the live polyps, the crown of thorns starfish *Acanthaster planci* reached plague numbers. Its feeding habits created a vicious ascending reproductive cycle; where it killed coral and beds of algae it created ideal sites to lay more eggs.

▽ Madagascan starfishes *Protoreaster lincki*, a sea urchin and a hermit crab.

▽▷ A common starfish *Asterias rubens* demonstrates the suction power of its tube feet.

▽▷▷ Murky meeting: common starfishes of all shades and sizes congregate in a dark crevice, surrounded by green sponge.





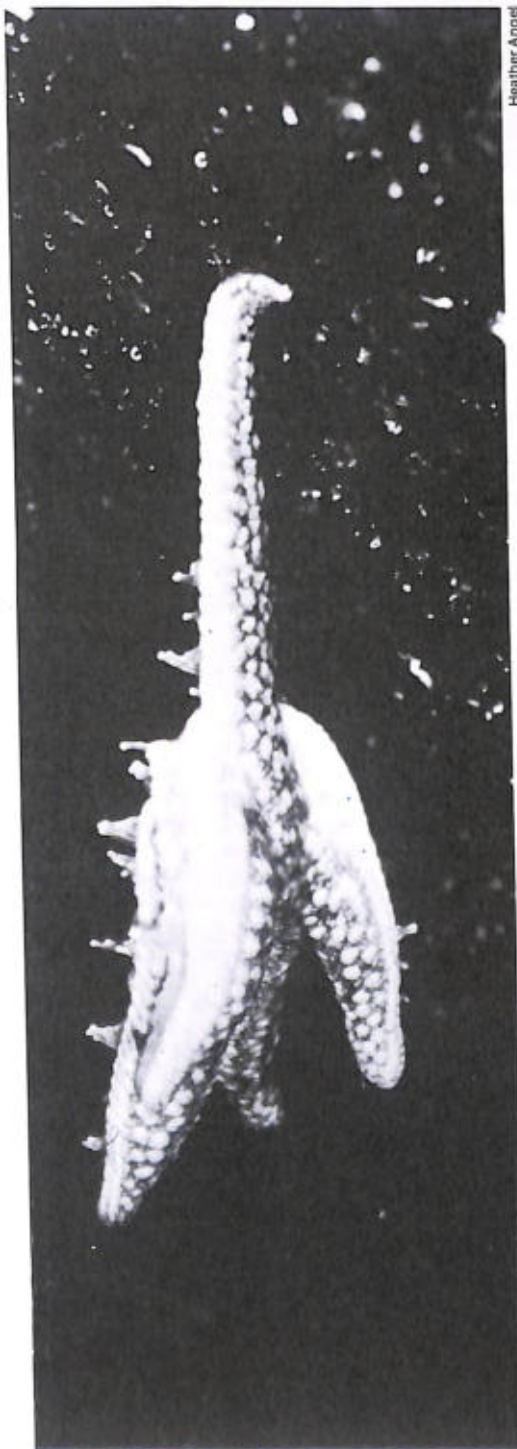
Edmund Hobson

Incredible story

Starfishes raid oyster and mussel beds and feed on the shellfish. These raids are, however, insignificant compared with the dramatic largescale destruction of coral reefs that took place a few years ago and may have had serious effects on fisheries with dangers of land erosion. The arch villain is the 'crown of thorns starfish' *Acanthaster planci*, so named for its covering of spines. It has 16 arms and averages 10 in. across, although it can reach two feet. It feeds on coral polyps. It was once thought a rarity—until about 1963 when swarms were reported on the Great Barrier Reef. At the same time it was implicated in the destruction of coral in the Red Sea. A population explosion took place in many widely separated areas of the

Pacific and other oceans and killed off coral at an alarming rate. In 2½ years it killed nine-tenths of the coral spread out along 38 kilometres of the shoreline of Guam. As the polyps are destroyed, the dead coral is overgrown with weed and most of the fish depart, their habitat ruined. The areas affected include the Great Barrier Reef of Australia, Fiji, Truck and Palau. At first it was thought the population explosion was due to pollution or other human interference, but it transpired this was a natural phenomenon which has now subsided.

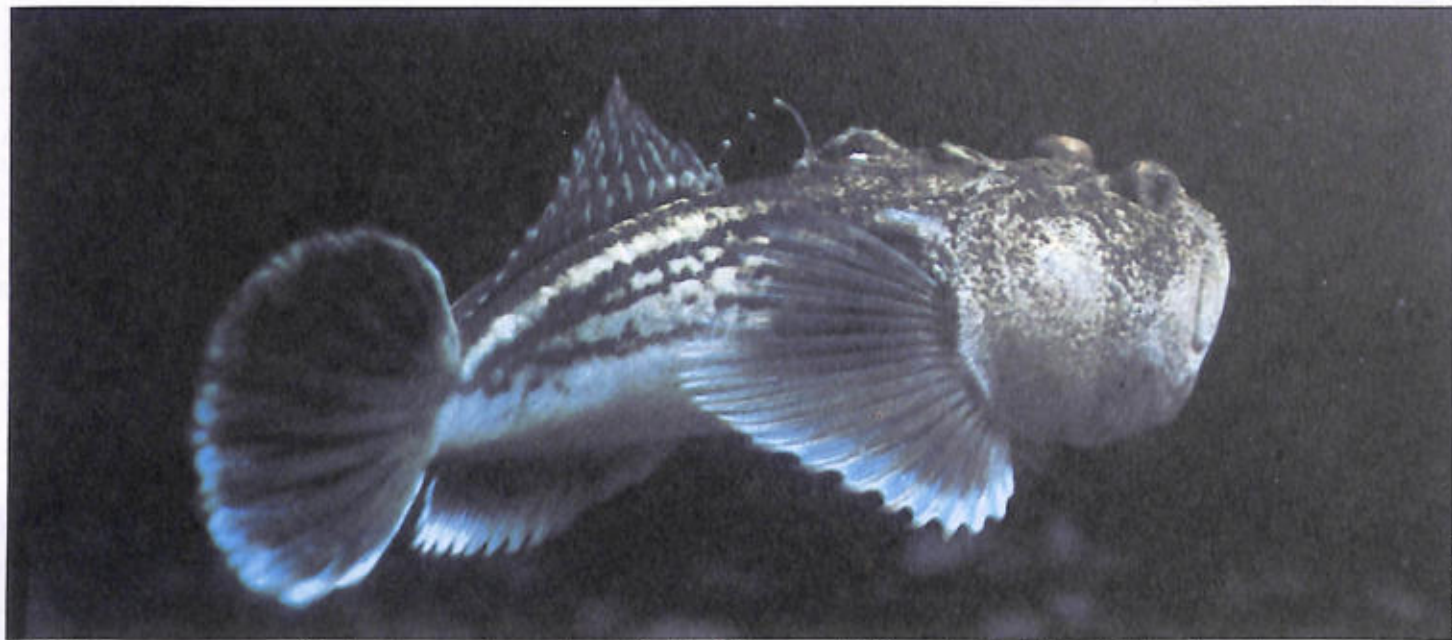
phylum	Echinodermata
class	Asteroidea
orders	Phanerozonia, Spinulosa, Forcipulata



Heather Angel



P. Reiserer: Bavaria



SG Giacomelli

This Mediterranean stargazer, like other types, gets its name from the position of the eyes, which lie on the top of the head looking upwards.

Stargazer

The stargazer is about as well equipped as any animal for getting an easy living and for beating off attacks on itself. It is also one of the ugliest of all fishes. Its head is large, broad and flat on top and the body, which is covered with small scales, tapers evenly from the head to the square-ended tailfin. Stargazers seldom exceed a foot in length, the largest being the northern stargazer of the Atlantic coast of the United States which reaches 22 in. The mouth is wide and the jaws are set almost vertical in bulldog-fashion. The wide set eyes on the top of the head gaze permanently upwards and behind each eye is a rhomboidal depression in the skin marking the position of the electric organs. The front dorsal fin is short and spiny, the second dorsal long and soft rayed, and the anal fin is long and soft like the second dorsal. The gill cover on each side is large, the pectoral fins are large and set low on the body and the pelvics are small and set under the throat. There are poison spines just above the pectoral fins, each having two grooves which carry poison from a gland at their base. The colour of the body is a dull brown which may be broken by whitish spots or stripes. In all cases the colours make the fishes inconspicuous even on sand or mud.

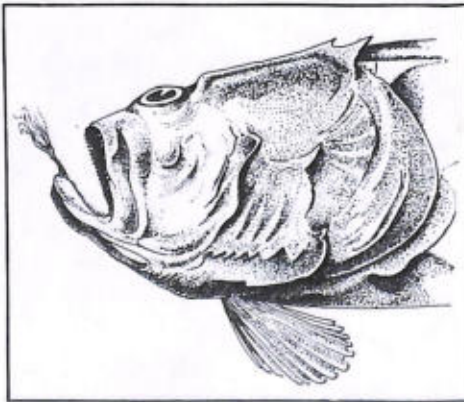
There are more than 20 species which live in both shallow and deep waters, mainly in tropical and subtropical seas throughout the world.

Everything to protect itself

Stargazers bury themselves in sand or mud by a squirming side-to-side motion in which the large pectoral fins seem to act as shovels. Once buried they move about very little, lying with just the eyes and nostrils showing

above the surface; in an emergency they can bury themselves temporarily to a depth of one foot. In most stargazers the nostrils open into the mouth, which is unusual in fishes, and water is drawn in through them to pass across the gills. The lips are fringed with short fleshy tentacles which may act as a filter to keep out sand.

Their electric organs can generate 50 volts, enough to make anyone touching them throw the fish aside and wonder what has happened. They are formed of modified eye muscles each of the electroplates representing a single muscle fibre. The poison spines are a second form of defence and there are reports of fatal accidents to humans although Caras in *Dangerous to Man* states he could find no evidence for this.



Chris Howell-Jones

Mediterranean stargazer with worm-like lure.

Feeding by fair means or foul

Any small animals swimming near the stargazer's mouth with its opening more or less level with the surface of the mud, is snapped up. These include small crustaceans and worms, as well as small unwary fishes. Stargazers also have a worm-like fleshy filament fastened under the tongue just inside the mouth that can be pushed out and waggled to arouse the curiosity of larger fishes, drawing them nearer the mouth, to be snapped up.

Normal infancy

Although they do not normally move about much there seems to be some migration, probably linked with temperature. Stargazers sometimes move into shallow temperate seas in summer, for example. They also apparently swim into deeper water for spawning. Until they are about an inch long the baby stargazers have the normal shape of young perch-like fishes with eyes at the sides of the head and mouth horizontal. Then, as the head flattens and the eyes move up, certain muscles of the eye change to form the electroplates.

Fair flavoured fish

The stargazers sometimes appear under the scientific name *Astroscoptes*, meaning literally to look at the stars. Others are called *Uranoscopus*, looking at the heavens, which amounts to the same thing. The Mediterranean stargazer, which was known to the Ancient Greeks and Romans, and was the first stargazer to be given a scientific name, carries the specific name *scaber* meaning rough, scurvy or untidy. It is an apt description of its appearance, and should be enough to put off anyone trying to prepare it for the table, yet stargazers are relished in several parts of the world. M Constantin-Weyer, who wrote *The Private Life of Fishes*, assures us that the stargazer is delicious, at least in a *bouillabaisse*.

class	Osteichthyes
order	Perciformes
family	Uranoscopidae
genera & species	<i>Astroscoptes guttatus</i> <i>northern stargazer</i> <i>Uranoscopus scaber</i> <i>Mediterranean stargazer</i> <i>others</i>



Arthur Christiansen

A green array of glossy starlings *Lamprolornis* decorate a tree in Ethiopia; African starlings are generally brilliantly coloured.

Starling

Taken as a family the starlings are highly successful but none can compete with the success story of the common starling. It is 8½ in. long with a stout body, a short tail and broad, pointed wings. Its plumage changes markedly throughout the year. Young starlings are brown and in their first autumn they moult to a spotted plumage with a brown head. At the same time the adults have light spots on a dark ground with a green iridescence, the spots of the female being bolder than those of the male. By the spring the spots are gone, due to the abrasion of the ends of the feathers, and all adults are then blackish, with iridescence. The bill is quite long and horn coloured in winter, yellowish in spring and summer. The changes are confusing but when its plumage is at its best the common starling is a handsome bird. So also are its relatives. The rosy pastor of eastern Europe and Asia has a pink body, a dark-crested head, and dark wings and tail. The glossy starlings of the South Pacific are greenish-black as adults but are heavily streaked with white when young. The oxpecker (p. 1793) or tickbird and the mynahs (p. 1696) are also included in the 110 species of Old World birds which make up the family. Some, like the African wattled starling, have further ornamentations. It moults its head feathers in the breeding season and grows long wattles.

Living clouds

Starlings tend to live in flocks and this is most marked in the common starling. During the day the flock spreads out for feeding but in the late afternoon all the starlings in the neighbourhood begin to come together for roosting. The pattern

of behaviour then varies. Typically, the birds begin to gather in small groups of 12–20, on bushes or in trees. Each group later joins a nearby group and the process of forming larger and larger groups continues until a flock thousands strong is formed which flies around and around, spreading out and coming together, like a huge smoke cloud in the sky.

Orderly roosting formations

Sometimes a flock of several hundreds will fly in formation, turning, wheeling and changing course with almost military precision. At other times the birds will make direct for the roost in small groups of twos or threes or up to a dozen. There are times when starlings will gather in trees in a noisy



A wattled starling—*Creatophora cinerea*.

chorus, the well-known murmuration. Then suddenly, as if cut by a knife, the chorus stops and a few seconds later all the birds take to the wing and fly off. As they fly away the last five or six birds return to the tree and start singing again. Other starlings fly in from all directions until 40–50 have assembled and a chorus builds up again. Then suddenly it ceases again, as if cut off with a knife and a few seconds later they all fly off in the same direction as the previous group, again a few birds detaching them-

selves from the rear and returning to the tree. The whole ceremony is re-enacted, perhaps six times, before all the starlings in the surrounding area have assembled and flown to the roost.

Nuisance in towns

In rural areas starlings roost in a clump of trees, fouling the ground beneath with their droppings, or in a church tower in a village. This was the pattern of their roosting everywhere until the 1890's, when they started to roost in towns. The first record in London was in 1894. Today there are two large dormitories, one centred on St Paul's cathedral, the other around Trafalgar Square. Every night, except in the breeding season, a vast flock assembles in these places, the individual birds perching on ledges and window sills for the night. On one occasion starlings settled in such numbers on the big hand of Big Ben they stopped the clock. Starlings roosting on buildings have now become a regular feature, especially in the larger towns. Many methods of driving them away have been tried, to save the buildings being fouled by their droppings, but they have all met with indifferent success.

Colonizing America

The common starling, native to most of Europe and western and central Asia, has been taken to Australia and New Zealand and to North America. Their most spectacular spread has been in America. Several unsuccessful attempts had been made to introduce them to the United States and Canada. Then in 1890 sixty were released in a New York park, and forty more in 1891. By 1948 they had spread all across the United States and reached the Pacific coast. They have now spread to Canada and Mexico.

Mainly beneficial to agriculture

In the 1920's a panel was set up in the United States to assess the effect of starlings on agriculture. Its report showed that starlings are beneficial because of what they eat and this slightly outweighs their nuisance

Constance P. Warner

▽ *Starling sequence: four common starlings perch on a branch in their white spangled winter plumage. At other times of the year the plumage is iridescent purple, green and blue. They are gregarious birds forming large flocks to roost. This has led to their becoming unpopular in large towns and cities where they congregate on window ledges and the upper parts of buildings which they foul with their droppings. They also make a lot of noise, their high-pitched squealings rising over the noise of the traffic. It is a pity that this attractive bird has become a pest.*

value in other ways, such as fouling the ground under their roosts and raiding soft fruits. For most of the year starlings probe the grassland and ploughed fields with their beaks for insect grubs, especially for the troublesome wireworm. They also feed among cattle, taking insects disturbed by their hoofs. At other times they take soft fruits and in autumn and winter they feed on berries, gorging themselves as long as a particular crop of berries lasts, whether elder, yew or rowan.

Selfish nesters

Most starlings nest in holes in trees. The Celebes starling, which has a bill like a woodpecker, excavates its own cavities in trees. The common starling also nests in holes in buildings and in roofspaces, and

will often drive other birds out of suitable nesting cavities. Breeding begins in April, the male building the nest, of leaves and dry grass, the female lining it. The eggs, 4-9 in a clutch, are very pale blue, sometimes with small red spots. They hatch in 12-13 days, the female incubating them at night, the two sharing the incubation by day. The fledglings are fed by both parents for 3 weeks. Starlings more than most birds tend to lay occasional eggs on the ground. Polygamy has been recorded, with one male mating with three females and helping each of them with the incubation and feeding of the fledglings.

Success against enemies

Much of the success of starlings, in building up large populations and in spreading over



new areas is due to their adaptability in using nesting sites, their wide diet and their own pugnacity—they will drive other birds from feeding tables. It is also due to the close-knit family life: starlings more than most birds seem to control and marshal their young, especially in times of danger. Attacks by birds of prey on flocks of adults are largely thwarted by the starlings flying in tightly packed box formations as soon as the enemy is spotted.

Sounds that deceive

Starlings are very vocal, but besides their native calls many are proficient mimics of the calls of other birds or of mechanical sounds. When a gull or curlew is heard calling and neither can be seen, it is likely

to be a starling on the roof-tops imitating their calls. Once, when the fountain in the garden of an English house had been turned off, the tinkle of falling water could still be heard; it was traced to a starling. Of the many records of their mimickings perhaps the most remarkable followed some tree-felling. A power-driven saw was being used to fell the trees. After this had been going on for a few days a starling was seen one midday, a quarter of a mile from the wood, while the woodmen were having their lunch, making the sounds of a distant power-driven saw. It followed this with a medley of sounds which made no sense until the listener realized it was the sound of a falling tree, with the swish of the twigs, the rustle of leaves, and the final crashing sounds as the limbs and trunk hit the ground.

class	Aves
order	Passeriformes
family	Sturnidae
genera & species	<i>Aplonis metallica</i> <i>long-tailed starling</i> <i>Sturnus roseus</i> <i>rosy pastor</i> <i>S. vulgaris</i> <i>common starling</i> <i>Scissirostrum dubium</i> <i>Celebes starling</i> <i>others</i>

John Markham



Steamer duck

The three steamer ducks are massive, ungainly birds that live in southern South America. The body is very heavy, weighing up to 14 lb in the largest species, the feet are large and the bill very broad.

The wings are short and two species are unable to fly. The Magellan flightless steamer duck is the largest of the three. Males weigh 12–14 lb and the females a few pounds less, but otherwise the sexes are very similar. The plumage is mottled grey. The head and neck are grey mottled with white, the crown is bluish-grey and there is a brownish tinge on the throat. It lives on the coasts of South America from Concepcion in Chile to Cape San Diego in Argentina, including the islands around Tierra del Fuego. The Falkland Islands flightless steamer duck is confined to the Falkland Islands where it is known as the logger duck. It is rather smaller than the Magellan species and the sexes have similar plumage. Both have darker bodies than the Magellan steamer duck and have a yellow ring around the neck. Females have a dark head with a white stripe running back from the eye while males have a paler grey head.

The flying steamer duck, the smallest of the three, with the males weighing about 6 lb, is found both in the Falkland Islands and in southern South America, from Valdivia in Chile and Puerto Deseado in Argentina south to Tierra del Fuego. The flying steamer duck has longer wings and tail than the flightless species and its legs are more slender. Its plumage is darker, being almost brown over most of the body and the male can be distinguished by a whitish head. All the steamer ducks have white patches on their wings which can be seen when the wings are folded.

Tame wild ducks

Steamer ducks are so-called because of their habit of 'steaming' over the water, rushing across the surface propelled by their wings and legs and throwing up sheets of spray. The flying steamer duck can fly well but prefers to 'steam' if disturbed. The Magellan steamer duck has been recorded as 'steaming' at 8 mph over short distances when chased by a boat. The flightless steamer ducks are confined to coasts and are rarely seen in fresh water except to drink and bathe. The flying steamer duck, on the other hand, regularly inhabits lakes and rivers. Coastal steamer ducks are rarely seen more than a few hundred feet from land and the Magellan steamer duck is not found on the parts of the South American coast where there are extremely large tides.

In the Falkland Islands where steamer ducks have few, if any, enemies, they are remarkably tame, as so often occurs with animals living on islands where there are no predators. In Port Stanley, the only town in the Falkland Islands, flightless steamer ducks live on the beach just below the main road. They take little notice of passing people and, in turn, are no more molested than the domestic duck on a village pond.

Fond of small shellfish

Steamer ducks feed on aquatic animals which they catch by diving in shallow water. The diet is mainly molluscs but also includes crustaceans, although the flying steamer duck with its smaller bill eats fewer thick-shelled molluscs than the others.

Father stands guard

In their breeding behaviour steamer ducks show several similarities to the shelducks (p. 2233), to which they may be related. They mate for life and the male vigorously defends the territory, not only against other steamer ducks but also against other birds, including other kinds of ducks, penguins and geese. Battles between male steamer ducks may be very violent. They swim towards each other sinking lower and lower

into the water, so when they meet they are almost submerged. They fight by grabbing each other's heads and beating with the wings which bear yellow knobs.

The 4–10 eggs are laid in a nest near the shore and are incubated by the female while the male keeps watch, either from the shore or from the water. Shortly after the chicks have hatched the female leads them to the water. They stay near the female but the male is always nearby and comes to the female's assistance if the brood is molested by gulls or skuas. Some chicks, however, are prey to these birds.

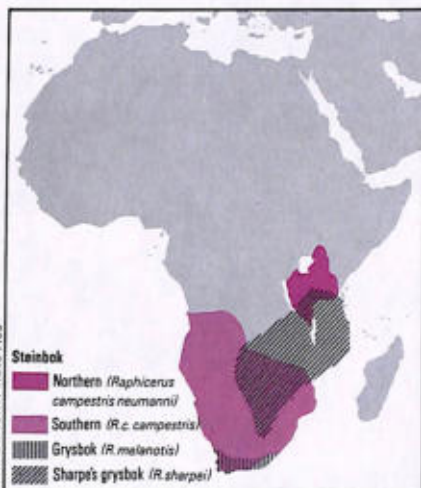
Tough bird

As with other flightless birds steamer ducks have been able to develop a much heavier stronger body than the fragile light bodied necessary in flying birds. A thick skull seen to be essential for the male steamer duck to be able to survive the battering they give each other. Blood is regularly drawn from these fights and many males bear the scars of past battles. The extreme toughness of the Falkland steamer duck was demonstrated by the American ornithologist O. Pettingill Jr, who spent some time in the Falkland Islands. He wanted to collect some steamer ducks for a museum collection but when he discharged a 12-bore shotgun at close range, his target merely walked away. Eventually a very heavy charge had to be used and when skinning the duck, Pettingill had to use a saw to cut through the skull.

class	Aves
order	Anseriformes
family	Anatidae
genus	<i>Tachyeres brachypterus</i>
& species	Falkland Island flightless steamer duck <i>T. patachonicus</i> flying steamer duck <i>T. pteneres</i> Magellan flightless steamer duck



Grounded pair: Falkland Island flightless steamer ducks stand bottled in shallow water.



Jane Burton: Photo Rep

Its senses alerted a male steinbok stares towards the camera before deciding if danger is imminent. Instead of fleeing when alarmed it will lie hidden in the grass. The map shows the discontinuous distribution of the four types of steinbok; the species have definite boundaries.

Steinbok

The steinbok is a dainty antelope with large eyes and ears, which makes it very appealing. With its relative the grysbok, it is closely related to the oribi (p. 1767) and the suni. The steinbok and grysbok are, like the suni, 20 in. or less in height and have a coarse, rough coat. The males have simple spiky horns. Where the oribi and the suni have ribbed horns set at an angle to the vertical, the steinbok and grysbok have smooth upright horns. Like the suni, they lack the knee-tufts and the bare patch under the ear of the oribi, the tail is short and not bushy and the underparts are white. The male has a small gland in the groin, and both sexes have a rounded gland $\frac{1}{2}$ in. in diameter, $\frac{1}{8}$ in. deep in front of the eyes.

The steinbok is a uniform reddish or greyish fawn and has no lateral hoofs, just the small subsidiary hoofs which many antelopes have, above and behind the main one. The two species of grysbok are smaller and have white-speckled coats and longer ears. The ordinary grysbok has small lateral hoofs and is deep rufous, while Sharpe's grysbok is tawny rufous with no lateral hoofs. In Sharpe's grysbok, as opposed to the other two, the face-gland is surrounded by very short hairs; in the other two it is surrounded by a large area of naked skin.

The steinbok has a discontinuous distribution: the southern race is found from southernmost Africa, except for the south-east coast, north as far as the Zambesi and southern Angola. The northern race, which is paler with white rings round the eyes, is found in western Tanzania and as far north as southwestern Kenya. The grysbok is found in the coastal region of the southwest Cape, as far east as 28° E. Sharpe's grysbok is found from Natal and Transvaal north into Tanzania, reaching as far north as 2° 30' S in the west of Tanzania.

Hermits of the bush

Steinbok and grysbok both live in scrub and bush country wherever there is sufficient undergrowth for them to hide. By day they lie up in the grass, or in old aardvark holes, only emerging at dawn and dusk to feed and move about. They are usually solitary. The most seen together at one time is three, probably a mated pair with their most recent young. Each individual—or pair, when two do come together—occupies a territory. Whether this is actually defended is not known, but the occupant does not appear to wander outside it, once the territory is established. The territory is marked by dung-heaps, which have the owner's scent on them and are scattered at points around the territory.

Ceremonial courtship

The female steinbok comes into season every three months, for about four days at a time. When she does, the male becomes very aggressive. The pair rub their faces together, exchanging secretions from their face glands, like duikers (see p. 809). The courtship ceremony also includes a 'leg-beat' or *Laufschlag* (see p. 1775). Gestation is 210 days; the female lies down to give birth, and in the wild it seems that birth usually takes place in a disused aardvark burrow. There is a birth peak in November and December, at least for the southern steinbok; more often twins are born rather than a single young.

Young Sharpe's grysbok were recorded to be 10 in. high at 20 days and to weigh 2–3 lb; this is somewhat more than half the adult height and a quarter of the adult weight—in fact a large youngster for such a small antelope.

Differing tactics

Leopards, cheetahs, jackals, and hawks are probably the most dangerous predators of these little antelope. The grysbok's usual response to danger is to lie hidden in the grass with outstretched neck. If it is seen, it scuttles swiftly away with its head straight out in front. The steinbok moves with more of a gallop, and it holds its head higher as it runs. When cornered, it often puts up a fight, butting with its head and striking out viciously with its hoofs.

Cousins under the skin

The dwarf antelopes include the steinbok and grysbok, the suni, oribi, dikdik, beira, klipspringer and probably the Vaal rhebok. They are very closely related to one another and belong to the Neotragini tribe of antelopes. They all agree in being very small, with dark uppersides and white undersides, in having simple spiky horns, glands in the face and on the knees and in various other characters. The largest is the somewhat aberrant rhebok *Pelea capreolus* which is 30–31 in. high. The oribi and beira may reach 28 in., but normally none is above 20 in. high. Some are rather divergent in appearance: the rhebok has thick rabbit fur and a swollen, glandular muzzle; the klipspringer has a peculiar pithy fur and high, truncated hoofs for rock-climbing; the dikdiks all have inflated noses and tufted crowns. This leaves the steinbok, suni, oribi and beira which are rather more closely related to one another and have perhaps rather intricate points of difference between them. They are, however, distinguished by behavioural characteristics as much as anything else, such as the gazelle-like 'stotting' or 'pronking' of the oribi and its extended gallop; the swift smooth run, after initial hiding, of the steinbok and grysbok; the dodging and twisting avoidance behaviour of the suni; and the wariness and agility of the beira. In courtship, too, there are differences, such as the male pushing his head under the female's hind-quarters in the oribi, or the facial rubbing of the steinbok; but the 'Laufschlag' or leg-beat is a common feature of all the dwarf 'antelopes', and shows that they are closely related to the gazelles. All the dwarf antelopes, except perhaps the beira, seem to be territorial and live in pairs.

class	Mammalia
order	Artiodactyla
family	Bovidae
genus & species	<i>Raphicerus campestris campestris</i> southern <i>R. c. neumanni</i> northern <i>R. melanotis</i> grysbok <i>R. sharpei</i> Sharpe's grysbok



Jane Burton: Photo Res

Curious steppe lemmings investigate the heather. A distinctive feature of the laboratory species is a dark stripe along the back.

Steppe lemming

The steppe lemming has the doubtful honour of displacing the traditional guinea pig as a laboratory animal. In North America it is called the sagebrush vole and it combines the characters of lemmings and voles. The steppe lemming is a stocky rodent $3\frac{1}{2}$ –4 in. long with a tail one inch long. It has the blunt muzzle and the small ears and eyes of a vole, and its face is covered with numerous very long whiskers. Its long, soft fur is grey to sandy in colour with the underparts buff to silvery white, and in the laboratory species there is a dark strip along the back. The legs are short, the toes have stout claws and the soles of the feet are hairy.

There are three species: *Lagurus lagurus*, the laboratory species, ranging from southern Russia to western Siberia, Kazakhstan and Dzungaria; *L. luteus* of Chinese Turkestan to Mongolia; and *L. curtatus* of southwestern Canada and the western United States.

Frugal grass eaters

Unlike the related rodents, the lemmings and voles, steppe lemmings live mainly in semi-deserts and dry steppes where grass is sparse, but they may also move into pastures and arable land. They are mainly nocturnal, only occasionally being seen by day, and they are active the year round. They live in loose colonies making short burrows each consisting of several tunnels with a number of entrances and several nesting chambers. Most desert rodents eat

mainly seeds but the steppe lemming feeds chiefly on green plants. So long as there is plenty of green food they need not drink. Laboratory animals do best on grass and hay with thin twigs of willow, seeds, grain and a limited amount of root vegetables, such as carrot and beet. If given too rich a diet they become overweight and the breeding rate drops.

Unintentional haymakers

Steppe lemmings do not move far from their burrows and in summer, when grass is most plentiful, wherever they feed they leave some of the grass lying on the ground. Some individuals, about 1 in 10, take this hay litter into their burrows to store as food. The rest of the colony use this store in winter when supplies are short, taking it as and when needed. Wasteful feeding and hoarding food are common among rodents. Yet there are a few animals, such as the pika (p. 1895), that can be said actually to make hay. The steppe lemmings may perhaps be in process of acquiring the habit.

Large infant turnover

Steppe lemmings make their nests of plant fibres. The American sagebrush vole breeds all the year round. The Asiatic species has up to five litters during summer. The gestation period is 20–22 days, 24–26 days in the American species, and there are usually 4–10 young in a litter. Nursing females—unusual among rodents—are very tolerant of each other and often live together when they have litters. In the laboratory a pair may have 10–12 litters a year. The babies weigh $\frac{1}{16}$ oz at birth. This is doubled in 5 days and doubled again in 12 days, by which time the eyes have opened and the babies have begun to feed themselves.

They are fully weaned 5–6 days later. The females are sexually mature at 60 days, the males at 60–75 days. The life-span is 2–2½ years, with a maximum of 3 years.

Ideal 'guinea pigs'

Steppe lemmings *L. lagurus* were first bred in the laboratory 30 years ago in the USSR and in the early 1960's colonies were established in Germany and England for research on diseases such as turalaemia and poliomyelitis. It was then realized that the species has only a small number of chromosomes and the individual chromosomes are easily distinguished. The lemmings are therefore an asset in the study of genetics and especially the genetics of cancer. The advantages, from the laboratory point of view, are that the animals are small, easy to feed and maintain, do not hibernate, are easily tamed, are docile in nature, and have no unpleasant odour. Moreover, they breed rapidly and grow quickly, so there is a quick turnover in terms of individuals. In their rapid succession of generations steppe lemmings have something of the advantages of the fruit flies *Drosophila* as regards genetical research and they are smaller than guinea pigs and therefore require less space—which is hard luck on steppe lemmings.

class	Mammalia
order	Rodentia
family	Cricetidae
genus	<i>Lagurus lagurus</i>
& species	others



A. Bannister: NHPA

Incredible birth: this *Bactrododema aculiferum* has just hatched from its tiny egg shell, having first pushed off the top of the egg, the operculum.

Stick-insect

Stick-insects are today more commonly kept as pets than probably any other insect. They are sluggish and live among the foliage of trees and bushes or in low-growing herbage, relying for protection on their resemblance to their surroundings. They are always long and very slender, usually with smooth bodies, although some species are spiny. The larger kinds look like twigs and may be green or brown; the small species and the young of the larger ones are usually green and resemble the midribs of leaves or the stems and blades of grass. Some are very large and the Asian species *Palophus titan* is the longest living insect, sometimes exceeding a foot in length.

Some stick-insects have wings but many are wingless, a condition that enhances their resemblance to twigs.

Stick-insects, with the leaf-insects, comprise an order, the Phasmida, once included in the Orthoptera together with the grasshoppers, mantids, cockroaches and others, but this group has now been divided into several separate orders. About 2 000 species of phasmids are known, the majority being found in the Oriental tropics. One species, *Bacillus rossii*, is native to Europe, ranging as far north as central France. Two kinds of stick-insects from New Zealand have become established in the extreme southwest of the British Isles: the prickly stick-insect *Acanthoxyla prasina* in Devonshire and on Tresco in the Scilly

Isles, and the smooth stick-insect *Clitarchus hookeri* also on Tresco and on an island off County Kerry, Eire. The so-called laboratory stick-insect *Carausius morosus* is an Oriental species often kept in schools and laboratories and more generally as a pet. It is a very easy insect to keep and breed and can be fed on leaves of privet, ivy or lilac. It cannot, however, survive out of doors through the cold winter in northern Europe and must be kept inside.

Dazzle and hide

Most stick-insects feed and move about only at night. By day they remain motionless and often appear to be 'feigning death'. In fact they pass into a hypnotic or cataleptic state during the day. When they are in this condition the limbs can be moved into any position and will stay there, rather as if the joints were made of wax. Some of the winged species are active by day. In many of these the hindwings—which are the only ones developed for flying—are brightly coloured but are entirely concealed when the insect is at rest. If it is disturbed the wings are suddenly unfolded and the resultant flash of bright colour is confusing to a searching predator. Then, when the wings are closed again, the bright colour suddenly disappears, so the exact position at which the insect has alighted is effectively concealed. This is a well-known protective device and is called 'flash coloration'.

All stick-insects are plant eaters and occasionally they become numerous enough to defoliate areas of woodland. In Australia there are two species which occur in swampy areas but also feed on agricultural crops where they sometimes cause serious damage.

Eggs like raindrops

All the phasmids lay rather large, hard-shelled eggs which look very like seeds. In some cases they closely resemble the actual seeds of the plant on which the insect feeds. The eggs are dropped by the females at random. The tap of falling eggs is often heard from the cages of captive stick-insects and a North American species *Diaperomera femorata* is sometimes so numerous that the sound of thousands of its eggs falling on the forest floor is as loud as that of rain.

Several hundred eggs are usually laid, a few each day, and they take a long time to hatch. Those of the laboratory stick-insect hatch in 4–6 months at ordinary room temperatures, but this can be speeded up to 2 months by extra warmth or retarded to 8 months by cold conditions such as an unheated room in winter. The eggs of the Madagascar stick-insect *Sipyloidea sipyloidea* will hatch in as little as one month if kept at 24°C/75°F–27°C/80°F, but at lower temperatures may lie dormant for up to a year.

The young look very like the adults in all except size and, in the case of the winged species, in lacking wings, which develop gradually during growth.

Many stick-insects reproduce by parthenogenesis, that is the females lay fertile eggs without mating. In these species the males are usually rare; in cultures of the laboratory stick-insect, for example, they number about one in every 4 000 females. Of the two New Zealand species already mentioned, the male of the prickly stick-insect is unknown and possibly does not exist. In New Zealand, males of the smooth stick-insect are almost as common as females, but no males have been found in the small British colonies of the same species and the eggs develop without fertilisation.

Odd colours

The laboratory stick-insect occurs in various colour forms ranging from green to shades of brown. The colour is determined by green, brown, orange-red and yellow granules in the cells of the surface layer of the skin. Pure green individuals cannot change colour, but the others regularly change, becoming darker at night and paler by day. The change is brought about by movement of the pigment granules within the cells. Brown pigments may move to the surface and spread out, making the insect dark in tone, or they may contract into lumps and move to the inner part of the cell so the insect becomes pale. The orange-red granules can also move about in this way, but not the green and yellow ones.

The alternation of colours becomes established by exposure to normal day and night, but once established it continues as a rhythm governed by the time cycle of 24 hours. A stick-insect conditioned to normal light change and then kept in permanent darkness will continue for several weeks to change colour every 24 hours, just as it did before. If it is kept in the dark by day and exposed to artificial light at night a reversed rhythm will develop in response to these conditions. This also persists for some time when the insect is kept continually in darkness with no light at all.



A. Bannister: NHPA

phylum	Arthropoda
class	Insecta
order	Phasmida
families	Bacteriidae Phasmidae

△ Remarkable camouflage: head of *Bactrododema aculiferum* with its ear-like projections looking very like broken off twigs.

▽ Precarious upside-down mating of *Gratidia* spp. The female holds onto the stem as the male clasps her—both beautifully camouflaged.

▷ Rare shot: 7-inch *Clemencatha regale*.



A. Bannister: NHPA



Stickleback

Sticklebacks are not just tiny fishes or tiddlers caught by small boys with a bent pin on a line. They were used in some of the earliest modern studies of animal behaviour, and today they are used in testing for polluted water.

All sticklebacks have a long body, large head and strong jaws. They range in size from 2½–7½ in., most being only 3–4 in. long. The colour is usually greenish to black on the back and silver on the belly, sometimes with dark bars on the sides.

They have two dorsal fins the first of which is made up of well spaced spines. The anal fin is similar to the second dorsal and lies opposite it. Each pelvic fin is one long spike and the pectoral fins are large. Most sticklebacks have a series of bony plates along each flank, the number varying with the species, and also within the species according to temperature and salinity.

There are a dozen species in the north temperate zone of the northern hemisphere and two of them range across Europe, Asia and North America. They are tolerant of salty water, at least two being found in the sea as well as in freshwater and two are wholly marine.

At home in river or sea

The 3-spined stickleback or tiddler, the most widespread, and the one we are most concerned with here, occurs throughout the northern hemisphere. It lives in all fresh waters except fast flowing mountain streams. It is also found in estuaries and along the coasts, and it has been caught 2–3 miles out at sea. It is not often found in stagnant or weed-choked waters, where the 10-spined stickleback, also known as the 9-spined, can live. Its distribution is similar to that of the 3-spined but is more local, both in North America and Eurasia. The 15-spined is wholly marine. In North America the 2½ in. brook stickleback is found in the fresh waters of the United States and Canada, and the 4-spined stickleback is common along the eastern seaboard, from Virginia to Nova Scotia.

Swarms of sticklebacks

There is a remarkable occurrence recorded by Thomas Pennant in the mid-18th century. He tells us that in the Welland river, in eastern England, sticklebacks could be seen in 'such amazing shoals as to appear in a vast body occupying the whole width of the river'. A local farmer used them to manure his land. A man employed to catch them used to earn four shillings a day at the rate of a halfpenny a bushel. This would represent the incredible amount of about half a million sticklebacks a day.

Armoured or not

The variation in the bony plates or scutes along the flanks has led to four types being named. There is the 'trachura' type, with a complete row of scutes from head to tail, found in the north of the range and in salty waters and usually in half-grown individuals only. In the same areas live the 'semi-armata' type with scutes halfway along the body. In fresh waters in England and France are the 'gymnura' type with 3 or 4 scutes behind the head, and the 'hologymnura' form, without scutes, found in the south of the range.

Mixed carnivorous diet

The food of sticklebacks is almost any small invertebrate, the size of the prey depending on the age of the fish. It includes small crustaceans such as water fleas and freshwater shrimps, worms, small molluscs and their larvae, aquatic insects and their larvae, and sometimes fish eggs. Corresponding marine invertebrates are taken by those living in salt water, and these grow more quickly and to a slightly greater maximum size than those living in freshwater.

Nest-building fishes

As the breeding season approaches the male becomes more brightly coloured, with red on the front part of the underside. He is then called a red throat. He takes over a territory and drives out other intruding sticklebacks. In the centre of the territory he

▽ *Breeding preliminaries: a male three-spined stickleback building his nest. The nest is held together by a secretion from a modified part of his kidney.*



Jane Burton: Photo Ries

builds a nest of small pieces of plants glued together with a sticky secretion from his kidneys. In the sea sticklebacks use pieces of the smaller seaweeds. The nest is lodged among the stems of water plants—among seaweeds in the sea—and when ready the male entices one or more females to lay her eggs in it. As each female lays and then departs the male enters the nest and sheds his milt to fertilise the eggs, which are just under $\frac{1}{2}$ in. diameter. These hatch in 5–12 days, according to the temperature, and during this time the male aerates them by fanning water through the nest. The 4-spined stickleback makes a nest with two holes in the top and the male puts his mouth against one hole and sucks water through the nest. The baby sticklebacks, $\frac{1}{4}$ in. long when hatched, are guarded by the male until they are ready to leave the nest. They

grow to 1–2 in. long in the first year. The life span in the wild is $3\frac{1}{2}$ years.

Enemies

In spite of their armatures of spines sticklebacks are eaten, more especially by kingfishers and grebes. They tend to be infected with tapeworm, but this varies with the locality. In some lakes they are all infected.

Study in courtship

The 3-spined stickleback became more than a sport for young anglers when Niko Tinbergen did his now famous study on its courtship. It provides a simple illustration, among other things, of the use by animals of sign stimuli. A male stickleback guarding his territory attacks another male because it has a red 'throat'. Even a wooden model

held in a stickleback's territory will be attacked, provided it has a red throat. A female, ready to lay, on entering the territory, turns her abdomen swollen with ripe eggs towards him as he approaches. On seeing this he swims excitedly in what is called a zigzag dance. He will respond in the same way to a wooden model having the same shape. Having danced to her, the male turns and swims towards the nest. She follows and enters it after the male has indicated its position by pointing his head at the entrance. She enters and he butts her in the flank with his snout and trembles, which makes her respond by laying. He then enters the nest after she has left it and fertilises the eggs. The spawning is the result of a series of orderly stereotyped actions, each successive step being touched off by a definite signal or sign-stimulus, the red throat, swollen abdomen, zigzag dance and so on. It is, however, not so stereotyped that it never varies. For example if the female is more than ready to lay she may make straight for the nest.

▽ A fifteen-spined stickleback: the slender *Spinachia spinachia* only lives in saltwater.



class	Osteichthyes
order	Gasterosteiformes
family	Gasterosteidae
genus	<i>Gasterosteus aculeatus</i>
& species	3-spined stickleback, others

▽ Not as dangerous as it looks: a male three-spined stickleback keeps a watchful eye on his young.



Stick-nest rat

Stick-nest rats rival the packrats (p. 1808) of America in the large nests of sticks they build. Early colonists in Australia called them 'native rats' or 'rabbit-rats' because their relatively large ears and blunt noses gave them somewhat the appearance of small rabbits sitting hunched up. Stick-nest rats vary in length from 5½–8 in. and the long hairy tail, slightly tufted at the tip, may be as much as 9¾ in. long in *Leporillus apicalis*. The fur is thick and downy, the upperparts varying from light yellowish and dull brown to pale grey-brown, with grey or white underparts.

There are three species of stick-nest rat. *L. conditor* and *L. apicalis* live in south-central Australia and *L. jonesi* on Franklin Island off the coast of South Australia. *L. jonesi* is distinguished by having shorter ears and not such thick fur which is coloured dark amber-brown on the back. *L. apicalis* has a slighter build, a paler greyish-brown back, white fur underneath and a white-tipped tail. The mainland species were once abundant but are now confined to a few areas, remote from human habitation. The island species, however, is more flourishing and has a much better chance of survival than those on the mainland.

Stronghold against predators

The stick-nest rats are unusual for their habit of building nests of sticks for shelter and breeding. Some of these are communal and house large colonies. The nests vary in size and structure to suit the local conditions. Those of *L. conditor* are usually constructed around a bush and the sticks are strongly interwoven among the stems and branches of the bush. The nests are built up to a height of about 3 ft and are up to 4 ft in diameter, sometimes larger. They are constructed with great care and form a stronghold against the dingo, and carnivorous marsupials and also against high winds. In the centre of the larger nests are several soft grass nests with numerous entrances and passages leading to them. In areas where the bushes are too small or weak to be used for supports, the nests are just loose heaps of sticks placed over rabbit warrens, the tunnels of which give the animals easy means of escape. Moreover, stones are worked into these unsupported nests and other stones are placed on top, as in Swiss chalets. The stones weigh the nests down, anchoring them against high winds.

On Franklin Island, *L. jonesi* sometimes builds enormous nests of sticks and debris on the top of the cliffs, housing extra large colonies of rats. One such nest was built on the abandoned nest of a sea eagle as a foundation. The larger nests are sometimes on top of penguin burrows and it has been observed that on the approach of danger, penguins, mutton-birds, bandicoots, and even black tiger snakes, will bolt into the burrows and tunnels with the rats.



John Morris Wood

Leporillus conditor is more rat-like than the other two species, although, but for the tail, it could be mistaken for a small rabbit.

On the shore or the flatter parts of the island the nests are small, housing usually only one pair of rats and made only of dried herbage or seaweed. In small nests there is only one chamber and one or two entrance tunnels; on the shore the nest may be no more than dried seaweed tucked between large stones.

Very little is known of the habits of *L. apicalis* except from reports of it dated 1864, but it seems it does not consistently build nests. Sometimes it will shelter in hollow trees or the deserted nests of *L. conditor*. It is gregarious like the other two species and also nocturnal.

Stick-nest rats can be easily tamed and make gentle pets.

Mainly vegetarian

They are largely vegetarian. *L. jonesi* on Franklin Island feeds mainly on the leaves of a plant *Tetragona*. There is, however, the suspicion that they may sometimes eat the eggs and young of birds. For example, there is the record of the nest of a striped brown hawk being built on top of a nest of *L. conditor*. Although the hawk did not molest the rats there were signs that the rats raided the nest when it was left unguarded.

Breeding

Little is known of the breeding habits of stick-nest rats except that the young are born in the soft grass nests in the centre of the stick nests. The female has four teats so probably, unlike most rodents, she has a fairly small litter. The young of *L. jonesi* are carried about by the mother, hanging from her teats which they grasp firmly in their mouths, a habit which originally gave rise to the mistaken idea that the rat was a pouchless marsupial. This habit, however, is seen in a number of small rodents in different parts of the world.

Cave owl an enemy

Dingos find it hard to penetrate the stick-nest shelters, so the chief enemy of the rats seems to be the cave owl. It preys especially on *L. conditor* on the desolate Nullarbor Plain where the owl lives in the numerous limestone caves. In the past the Aborigines

hunted the rats for their flesh and in settled parts of New South Wales *L. apicalis* is thought to have been exterminated by introduced foxes and domestic cats.

Early observations

The stick-nests of *L. conditor* were first observed by Surveyor-General Mitchell on his expedition into the interior of eastern Australia in 1838. When Mitchell's party first saw the numerous piles of sticks on the plains of the Murray and Lower Darling in New South Wales, they naturally thought they were piles of brushwood put there by Aborigines for their signal fires. They had no reason to suspect rats because this as a rodents' habit was then unknown. Closer examination of these carefully-constructed nests and the fact that the kangaroo dogs scratched and barked at them, made Mitchell and his party curious, and on breaking open a nest—with the utmost difficulty—they found the soft nests inside containing small animals which 'might readily pass for a small rabbit but for the tail'. Unfortunately Mitchell did not keep careful watch on any animal in the nest and reported that the nests were made by the white-footed rabbit-rat, *Conilurus albipes*, a rodent common then in New South Wales and Victoria, and a relative of the stick-nest rats.

It was not until 1844 when Captain Sturt led an expedition into central Australia that it was realised the animal was a distinct species and it was given the specific name of *conditor* meaning a maker or contriver. Sturt brought back a specimen of the rat and in his narrative of the expedition dated 1849 he gives a full account of the animal and its unusual nest-building habits, illustrated by drawings.

class	Mammalia
order	Rodentia
family	Muridae
genus	<i>Leporillus conditor</i>
& species	<i>L. apicalis</i> <i>L. jonesi</i>

Stifftail

Stifftails are a group of ducks which have their tails made up of stiff feathers. They are small ducks, 14–18 in. long, and have a characteristic short, thick neck which can be inflated by an airsac under the oesophagus. The bill is broad, the wings short and the feet large. The plumage is often finely spotted and barred, with the underparts white mottled with brown, but no metallic sheens as are found in other ducks. Stifftails are found in most parts of the world but the majority of them are poorly known.

Among the better known stifftails is the ruddy duck of America and the white-headed duck of Eurasia. The ruddy duck ranges from northern Canada to Tierra del Fuego, being found over most of North and Central America and the West Indies, but is restricted to the region of the Andes in South America. In its breeding plumage the male is chestnut above, mottled white and brown underneath. The head is black except for white cheeks. The South American population is divided into two subspecies the Peruvian ruddy duck which lacks white cheeks and the Colombian in which they are mottled. The white-headed duck that breeds in parts of Europe, Asia and North Africa is similar to the ruddy duck but is less chestnut above. The maccoa duck of southern and eastern Africa and the blue-billed duck of Australia are like the ruddy duck but lack the white cheeks. Other stifftails include the white-backed duck of Africa, the musk duck of Australia with a strange lobe under the bill, and the black-headed duck of South America.

Grebe-like ducks

Stifftails are usually found on freshwater, preferring ponds and marshes where there is plenty of food. They are good divers, resembling grebes in their behaviour and associate with them rather than with other ducks. If alarmed, they can slowly submerge until only the head is showing, then disappear without a ripple. Their progress on land also recalls grebes and divers. They cannot walk properly because their legs are placed well back so they shuffle along on their bellies. The dependence of stifftails on water is further shown by the difficulty of introducing them to collections; they suffer on long journeys from not being able to swim. Although stifftails find difficulty in take-off they fly well and some species migrate. Their flight is heavy because their wings are small compared with their heavy bodies.

Varied diet

The food of stifftails is aquatic plants and animals. The white-headed duck eats mainly leaves and seeds, and also fly larvae, snails and crustaceans. The masked duck eats mainly weeds and the musk duck is most unusual in that it has a carnivorous diet and will even attack smaller ducks.



Phillippa Scott



◁ Foaming at the bows a ruddy duck, as part of his courtship display, coyly flicks his tail up over his back and presses his bill into his puffed up breast. This North American ruddy duck is characterised by its white cheeks.

▽ A male white-headed duck in breeding plumage. The stifftails are a group of extremely aquatic freshwater ducks. Their stiff tails probably serve an important underwater function when they dive for food or quietly submerge, disappearing from view with hardly a ripple.



Phillippa Scott

Helpful males

Because they nest in thick reed beds in inaccessible places the breeding habits of some stifftails are poorly known. In general, the nests are elaborate and well hidden. The eggs are very large, sometimes as big as those of ducks three times their size. The male helps care for the family, although he does not help to incubate.

The courtship behaviour of male stifftails with their bright plumage is quite spectacular. They inflate their throat sacs so they look like pouter pigeons and tilt their tails over their backs, repeatedly pressing the bill into the inflated breast and clucking or squeaking. The male Argentinian ruddy duck has been described as bringing its bill down on its inflated chest with such force that it produces a drumming sound audible up to about 50 yd away.

The nest is built among sedges, reeds or bulrushes which are arched over the nest for better concealment. The white-headed duck sometimes builds floating nests but more often the nest is firmly woven into standing plants. The white-headed duck and the blue-billed duck sometimes take over the abandoned nests of coots, grebes and other ducks.

The ruddy duck lays up to 14 eggs which together may weigh 3 lb, the equivalent of three times the weight of the duck that laid them. The usual clutch is smaller but up to 20 have been found in one nest. The chicks hatch in 3 weeks and shortly after they are escorted to the water by both parents. They can dive for food almost immediately.

Strange ducks

The Australian musk duck is peculiar on account of the pouch under the bill, which is larger in males than in females, and of the musk gland which secretes an unpleasant odour in the breeding season. Not surprisingly, musk ducks are not good to eat, although this is probably due to their largely carnivorous diet; the ruddy duck feeds mainly on plants and is good to eat. The musk duck also kills other water birds, attacking them from under the water.

Another species with unusual habits is the black-headed duck. It is not very closely related to the other stifftails. It is probably an aquatic cuckoo because its nest has never been found but eggs that are very likely to be those of the black-headed duck have been found in the nests of other birds, even in those of caracaras.

class	Aves
order	Anseriformes
family	Anatidae
genera & species	<i>Biziura lobata</i> musk duck <i>Heteronetta atricapilla</i> black-headed duck <i>Oxyura australis</i> blue-billed duck <i>O. jamaicensis</i> ruddy duck <i>O. leucocephala</i> white-headed duck <i>O. maccoa</i> maccoa duck <i>Thalassornis leucotis</i> white-backed duck

Stilt

The stilts belong to the same family of waders as the avocet (p. 259) and the ibisbill. While the bill of the avocet is turned up at the tip and that of the ibisbill turned down, those of the stilts are straight. Stilts have proportionately longer legs than any other waders and the head and body length is about 15 in. The stilt *Himantopus himantopus* is black and white and has a very large range and a variety of common names to describe its different races. The black-winged stilt breeds in Africa, southern Europe and Asia, from the Mediterranean Sea to China and occasionally in the Low Countries. There are only two records of breeding in Britain, both in 1945. The American race, called the black-necked stilt, has a continuous black band from the crown to the back. It breeds from the southern United States to northern South America, including the Galapagos Islands and the West Indies. In Australia and New Zealand the local race is called the white-headed or pied stilt. In parts of New Zealand there is a black stilt, which is probably no more than a black variety of the pied stilt.

The second species is the banded stilt which is found only in Australia. It is black and white with a chestnut band across the breast. The related ibisbill *Ibidorhyncha struthersii* lives in the high country of Central Asia.

Useful long legs

Stilts live in pairs or small flocks around shallow lakes, slow rivers, marshes and flooded agricultural land, preferring shallow water where there is plenty of water weed and low plants but not water overgrown with reeds. The banded stilt lives near temporary salt lakes and occasionally it is seen in estuaries, but it appears to shun freshwater. Stilts walk with a slow, graceful gait picking up their slender pink legs and placing them delicately, in long strides. In flight, stilts have a rapid wingbeat and they carry their heads held in. On long flights they trail their legs behind the tail making an unmistakable silhouette. On short flights and when they are manoeuvring, stilts use their long legs as a rudder.

Picking and probing

Most of the stilts' food is picked up from water plants or from the surface of the water but they also probe in the mud as they wade in shallow water up to their 'knees', and occasionally up to their bellies. This simple feeding behaviour is reflected in the unspecialised straight bill, which contrasts with the avocet's upturned bill, used for sweeping the mud and the ibisbill's downturned bill, used for probing under stones.

Stilts eat a wide variety of food; mainly insects such as water beetles, fly pupae and larvae taken from the water and caterpillars picked off leaves, as well as worms, snails and tadpoles. Banded stilts depend mainly on crustaceans from salt lakes.



◁ Tilted stilt in a salt marsh: a black-winged stilt searches for insects among plants of *Salicornia*. It also feeds in water, its extra long legs enabling it to feed in deeper water than most other waders.

▷ Its long, thin legs stretched out behind it, a black-winged stilt rises skywards.

▽ A family profile: adaptive radiation of bills in the *Recurvirostridae*, associated with different methods of feeding. The avocet's bill is the only one that befits the family name; it is swept from side-to-side to catch small invertebrates. The straight bill of the stilt is the least specialised—used to pick food off water plants or gently probe in the mud. The bill of the ibisbill is a more efficient probe for getting food from under stones.

▽▽ A baby black-winged stilt paddles awkwardly along with its oversize legs.

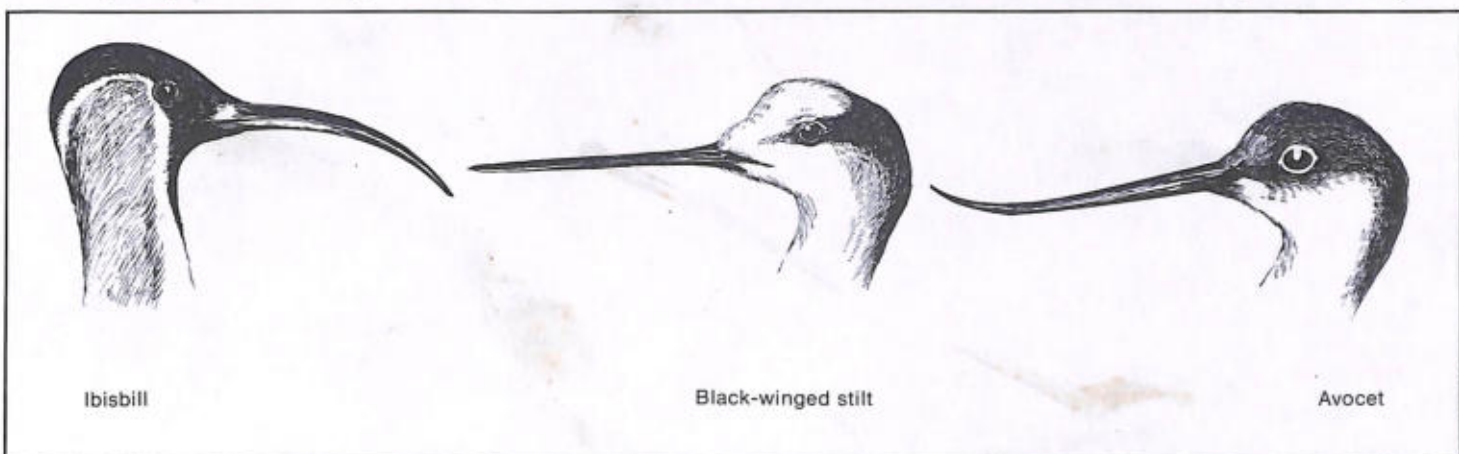


Vaucher: WWF

Nesting hazards

Stilts nest in colonies near their feeding grounds, and sometimes the nests are built in shallow water. They may be no more than scantily lined hollows especially if in a tussock of grass or they may be substantial structures of plants and mud. The clutch is usually of 4, sometimes 3, eggs which are incubated by both parents. The chicks hatch out in 25–26 days and leave the nest soon afterwards. Their parents defend them by flying around intruders and performing distraction displays.

The nests of the banded stilt were not discovered until 1930 when a colony was discovered at Lake Grace in Western Australia. Since then other colonies have been found, some with tens of thousands of stilts, but nesting does not occur regularly at any one place. It is dependent on the rainfall in an area as this controls the availability of food and the suitability of the nesting sites.



Ibisbill

Black-winged stilt

Avocet

Chris Howell-Jones



JLS Dubois: Jacana

For instance, attempts have been made to nest at Lake Grace since 1930 but they have failed through flooding.

Mixed breeding

At one time the black stilt of New Zealand was thought to form a separate species but it is now generally considered to be a black form of the pied stilt, with which it can interbreed. In recent years the pied stilt has greatly increased while the black stilt has been reduced to about 100. It has been supposed that the black form is the original New Zealand form and that the pied form is an immigrant from Australia. Why the pied stilt should be so successful, apparently at the black stilt's expense, is not known. Interbreeding produces intermediate forms which would tend to reduce the populations of black forms, but the amount of interbreeding is limited by the black stilt's preference for mating with its own kind.

class	Aves
order	Charadriiformes
family	Recurvirostridae
genera	<i>Cladorhynchus leucocephalus</i>
& species	<i>banded stilt</i> <i>Himantopus himantopus</i> <i>black-winged stilt</i>



Stingray

To say stingrays sting is an under-statement: they wound with a thrust of a poison dagger. Pliny, the Roman naturalist, wrote that the spine was as strong as iron, would pierce armour like an arrow, and driven into its root would cause a tree to wither.

The stingrays, related to skates, have a flattened body with wing-like pectoral fins and a whiplike tail bearing a long poison spine. The disc-like body may have a rounded leading edge or it may be drawn out slightly into a pointed snout. The pectoral fins and the pelvics are also rounded. The surface of the body is smooth with few or no denticles. The tail is slender and at least as long as the rest of the body. The spiracles are larger than the eyes. There is no dorsal fin, and the most obvious feature is the spine set in the tail, about a third of the way along. The upper surface is usually grey or brown, sometimes with white spots or with darker marbling. The undersurface is white to creamy white. Stingrays measure from 12 in. to 14½ ft across the fins, and weigh from 1½ lb up to 750 lb.

The 100 or more species live in tropical and temperate seas, as far north in summer as southern Scandinavia in Europe and equivalent latitudes elsewhere. They all live in shallow seas, seldom going deeper than 400 ft. Some species enter estuaries and even go up rivers, in a few instances for considerable distances.

Rapid action poison

Stingrays, like skates, spend much of their time on the seabed, searching for prey or merely resting. They move by wave-like undulations passing along the two pectoral fins, the tail being useless for swimming. When attacked, or even if only disturbed, the ray lashes with its tail, from side to side in some species, or bringing the tail up and over the body in others. This brings the swordlike spine into play. It is up to 15 in. long in the largest of the rays, with saw-toothed edges and grooves. The grooves are lined with a glistening white tissue which probably contains the poison.

The stab from a stingray not only injects poison, but also cuts and tears the flesh, and many people that have trodden on a stingray lying in shallow water have had to have stitches in their feet. Even a tiny puncture from the spine of a stingray has made a man faint. The effect of the poison is immediate and inflammation spreads around the wound almost as soon as the spine has penetrated. Other immediate symptoms are sharp shooting pains and throbbing. The poison affects the heart, breathing and nerves and it can be fatal although there are fairly simple remedies provided they are applied quickly. At one time washing the wound with iodine or permanganate of potash was recommended. Today, the treatment is to clean the wound, then immerse it in hot water for up to an hour, and give an anti-tetanus injection.



Hilmar Hansen

△ Dappled danger: *Potamotrygon*, a species from South America which never leaves freshwater.
◁ An unwelcome inhabitant of the Bahamas' shores: *Dasyatis americana* moves off.

Clam-cracker

The mouth of the stingray is on the under-surface of the head. The jaws are wide and both have blunt teeth arranged like a pavement in rows, with several rows of broad teeth in the middle and rows of smaller teeth on each side. A North American species known as the stingaree is also called the clam-cracker. Its food, like that of other stingrays, is mainly molluscs and crustaceans, and sometimes fish.

Born alive

All stingrays are ovoviviparous. That is, the eggs are not laid but hatch in the oviduct, the young being eventually born alive. At first the young feed on the yolk in a yolk-sac hanging from their abdomens, the food passing direct into the digestive tube from the yolk-sac. Then, at a later stage, blood vessels grow out and around the yolk, and food is taken into the blood. Later tiny filaments grow out from the walls of the oviduct. Each has a network of tiny blood vessels and gives out a liquid food which the embryo stingray takes through its mouth or through its spiracles. It is the equivalent of the placenta in mammals.

Bayonet teeth

Rays and sharks do not have scales like bony fishes. Their skin is protected by dermal denticles (or 'little teeth in the skin'). Each denticle is made up of a pulp cavity inside a

layer of dentine with a kind of enamel on the outside. These were once thought to be the equivalent of real teeth but with further biochemical research it is now realized they are not. For example, the 'dentine' is not true dentine. It has not yet been decided whether the spine of a stingray is a modified, and greatly enlarged, dermal denticle or not. One thing it shares with true teeth is that the spine may be replaced by a new one. Should the old spine not drop out before the new one grows out, the stingray may temporarily have two spines with which to lash its enemies, and exceptionally it may have three or four. These niceties would have held no interest for the peoples of the South Pacific who used them for spearheads. One of the dangers of being wounded by a stingray is that the poison tissue in its grooves may be left behind in the wound. Even worse, the spine may snap off and the piece left in the wound is very painful to remove. It is the equivalent of the saw-edged bayonet that was banned years ago.

class	Chondrichthyes
order	Rajiformes
family	Dasyatidae
genus	<i>Dasyatis pastinaca</i>
& species	others



Stoat

The stoat, a relative of the larger polecat (p. 1950), is up to 17 in. or more in length including $4\frac{1}{2}$ in. of long-haired tail. The males are larger than the females, weighing from 7 oz to 1 lb, while the females weigh only 5–10 oz. The fur is reddish-brown with the white underparts and throat tinged with yellow. The tail is the same colour as the back except for the tuft of long black hairs on the tip. Like the polecat, the stoat can secrete an objectionable odour from its scent glands, but this is not quite so offensive as in the larger animal.

In winter in the northern parts of its range the stoat's fur becomes white all over, with the exception of the tip of the tail which always remains black. It is then known as ermine and is valuable to the fur-trade. In Great Britain the traditional ceremonial robes of royalty and nobility have always been made from ermine.

The stoat is widespread in Europe from the Alps and Pyrenees to the Arctic shores and east into Asia. It is also found in North America where it is known as the short-tailed weasel. The stoat is found throughout the British Isles and a smaller local race, varying somewhat in colour, is found in Ireland where it is known as the weasel. Another local race, the Islay stoat, is found on the Islands of Islay and Jura on the west coast of Scotland.

Snake-like hunter

The stoat is found in most types of country, hunting along hedgerows, across fields, by rivers and brooks or wherever there is a chance of food. It moves characteristically in a succession of low bounds, its long, lithe body assuming an almost snake-like appearance. It can swim and climb well. Its senses of smell and hearing are acute but its sight is poor. Whether hunting or not, the stoat is alert, agile and energetic, with a natural ability to take advantage of cover. A common trick is to use the runs of moles or rats, either to escape enemies or to hunt prey. There are a number of accounts of stoats playing together, twisting and turning like snakes, zigzagging over the ground, rolling over each other, somersaulting on the ground or in mid-air, leaping anything up to four feet into the air and, finally, sitting up on their hind-legs and boxing furiously with their fore-paws.

Although largely nocturnal in its habits, there is a good chance of seeing a stoat hunting in broad daylight.

Truly carnivorous

A stoat hunts largely by scent, picking up the trail of its prey and following this relentlessly. Truly carnivorous, it rejects little that is flesh. Until the disease myxomatosis reduced the numbers of rabbits in Europe, they formed the stoat's main food. A rabbit will cry out in terror, apparently paralysed with fear, even while the stoat is some way off. Similarly, a hare, which can outwit a



△ As a tribute to her virginity, the artist portrays Queen Elizabeth I with an ermine on her sleeve.
◁ Ermine not stoat. Except for the black tip on its tail, which always remains black, this stoat has moulted to its winter coat, having discarded its brown summer coat in a matter of days.

fox or a pack of trained hounds, becomes so terrorised that it hardly tries to escape.

Given the opportunity a stoat can be destructive to game and poultry, which has led to its persecution by gamekeepers and poultry farmers from early times. The fact that it also destroys vermin is not so commonly stressed. Moles, rats, mice and voles are killed by a bite at the back of the neck. It also takes fish, small birds, eggs and reptiles. It will sometimes employ tactics known as 'charming' (see red fox p. 2063).

Family parties on the hunt

Fertile matings take place in March and again in June and July and because the males are partially sexually active until October, infertile mating may take place after July. After fertilisation in the spring and summer, implantation is delayed until the following spring, after which there is a gestation period of 20–28 days. The nursery is made in a hole in a bank or the hollow of a decayed tree and in April or May 4 or 5 young are born, occasionally 6–9. The female alone tends the young, which she will defend fiercely against all dangers. She has only one litter a year. The babies are covered with fine white hair at birth, the black tip appears on the tail at

20 days and the eyes open at 27 days. Weaning is at 5 weeks of age.

The young remain with their mother after weaning and hunt with their parents in a family party. Two or more family parties may join up, like some of the larger carnivores, to form the well-known packs of stoats that are reputed to attack dogs and even men. When, through an increase in their numbers, the food supply of a district is largely reduced, the stoats sometimes migrate in large numbers. There are reports of several scores of them moving across country in a column, but these stories are viewed with caution by many zoologists. Apart from man the stoat has few enemies, but young stoats and a few adults are taken by owls and hawks.

Change in colour

It was believed for a long time that the change in the colour of the coat in autumn was caused not by the loss of hairs but by the loss of pigment in the hairs. This is now known to be incorrect. A stoat moults twice a year in spring and autumn and, as has already been said, its coat turns white in northern latitudes. The change from brown to white is very rapid because the



Popperfoto

△ A stoat on the look-out, its body sprung for action. It is a remarkably fast and agile animal. An expert hunter, it will climb trees and pursue its prey into small holes and burrows.

▷ A first look at life: two young stoats gaze inquisitively at the world about them.

new white coat grows underneath the old one. The old coat may be shed in as little as three days in very cold conditions.

The accepted idea is that the summer russet coat is protective in that it harmonises generally with the colour of the leaf litter over which the stoat is moving, and that on snow-covered ground, as in Alpine districts, the change to a white fur enables the stoat to steal up on its prey unseen. It is not easy, however, to accept this when we recall the behaviour of rabbits and hares in the presence of a stoat. Their

terror must almost certainly be induced by the sight of the animal. Even if it were induced by smell, it would still suggest that any coat colour is not of primary value as camouflage. More likely, a white coat cuts down the loss of body heat, as in the plumage of the ptarmigan (p. 1995).

Although the matter has not been fully investigated, experiments have shown that the change in colour of the stoat's coat seems to be dependent partly upon temperature and partly upon day length. Since both these factors are variable many permutations can

result. In North America, for instance, all stoats turn white in the north, and in the south all remain russet, but there is a zone between where white, particoloured or russet stoats are found in winter. Again, in the south of England, an occasional stoat will turn white in the autumn, whereas others may be partly white and partly coloured. Both these forms may occur in a mild winter when there is little or no snow. One explanation for this is that temperature may also have a delayed action, so that a stoat experiencing lowered temperatures in one autumn may turn white in the following autumn even if temperatures are high. But the fact that white or partly white stoats in southern England tend to be localised suggests that the change is genetic.



class	Mammalia
order	Carnivora
family	Mustelidae
genus	<i>Mustela erminea</i>
& species	<i>stoat, ermine or short-tailed weasel</i> <i>M. e. hibernica</i> Irish weasel <i>M. e. ricinae</i> Islay stoat



Albert Visage - Jacana



Eric Hosking

Stone curlew

The stone curlews or thickknees are strange-looking waders, the nine species making up the family Burhinidae. The former name is due to their preference for pebbly ground and the latter to the swollen 'knee' joints. They range in size from 14–21 in. long. The legs are fairly long, the feet slightly webbed and the hindtoe is missing. The bill is usually short and thick, yellow or green with a black tip, and the eyes are large. The plumage is dull grey with streaks of brown and black.

The European stone curlew, about 16 in. long, has sandy-brown plumage with black streaks and white wing bars. The bill is short and straight. It lives in Europe, including the British Isles, from Poland and Germany south to the Mediterranean, in Africa south to Kenya and in southern Asia. Other stone curlews include the water thickknee of South Africa and the bush curlew and beach curlew of Australia. The beach curlew is 21 in. long and has a massive bill which is slightly flattened and upturned. Other stone curlews are found in tropical and temperate regions, including South America, but are missing entirely from North America, the islands of the Pacific and New Zealand.

Waders far from water

Although they are waders, most stone curlews are found well away from water, often in dry upland regions or in sandy country. The bush curlew is found in light wooded and open country; the double-striped thick-

knee is found in the savannahs of Central and South America and the South American thickknee is found in the sandy deserts of Peru and Ecuador. As the lack of a hind toe suggests, they are strong runners and there is some indication that they are more closely related to bustards than curlews. When the bush curlew, for instance, is chased it seeks safety by running, and if it does take to the air it has to taxi to take off. Then it lands quickly and runs into cover.

Stone curlews are nocturnal, as is suggested by their large eyes, the pupils of which contract considerably during the day. At night the stone curlews are very noisy, producing cries which are often mournful, rather like those of curlews. During the day they are quiet and lie up in cover. When disturbed they flatten themselves with their head and neck extended; so with their drab plumage they are very difficult to find.

Mainly insect diet

Stone curlews feed on insects, such as beetles, grasshoppers and fly maggots, and on snails, slugs and worms. Those that live near water also feed on crustaceans. Small rodents, chicks of game birds, amphibians and reptiles are also eaten.

Pre-fab nests

At the start of the breeding season male stone curlews display vigorously, running about with outstretched wings. No nest is made and the two eggs, one in the beach curlew, are laid in a bare scrape. The water dikkop sometimes lays its eggs on the dried droppings of elephants or hippopotamus. At the start of incubation the parent stone curlew quietly creeps away from the nest when disturbed, but later it sits tight. Both parents incubate the eggs, which hatch in 25–27 days. The chicks leave the scrape shortly after hatching.

△ Proud parents with their chick, the stone curlew *Burhinus oedicnemus*. The nest is just a depression scraped in the bare ground.

Watch dog for crocs

The water dikkop is one of the so-called crocodile birds (see courser, p. 676). There seems to be no evidence that the water dikkop takes food from a crocodile's mouth, as crocodile birds are traditionally supposed to do, but it does associate with crocodiles during the nesting season. Both animals breed on sand banks when the rivers are low and water dikkops can be found sitting on their eggs only a few feet from a crocodile guarding its own nest. They are probably safe because when not actually hunting, the crocodiles are not concerned with food. The birds may even gain protection from nest predators by the crocodiles' proximity. The crocodile is in return given warning of enemies by the water dikkop's alarm calls. Hippopotamus also heed the water dikkop's warnings and in South America double-striped thickknees are hand reared by the local peoples to act as watch dogs.

class	Aves
order	Charadriiformes
family	Burhinidae
genera & species	<i>Burhinus vermiculatus</i> water dikkop (water thickknee) <i>B. bistriatus</i> double-striped thickknee <i>B. superciliaris</i> South American thickknee <i>B. magnirostris</i> bush curlew <i>B. oedicnemus</i> European stone curlew <i>Orthorhamphus magnirostris</i> beach curlew, others

Stonefish

The stonefish is almost the ugliest, if not the ugliest of all fishes and it is certainly the most poisonous. A stonefish is 6–12 in. long, has a heavy head which is broad and flat, and the body tapers rapidly from behind the head to the small tailfin. The mouth is wide and has a fairly large gape. The pectoral fins are large and winglike. The dorsal fin, which runs along the midline of the back, is armed with 13 stout spines. There are three more spines on the anal fin and one on each of the pelvic fins. The scaleless skin is covered with many irregular warts and a layer of slime. The colour of the fish is best described as the colour of mud, seaweed or stone—and if stones vary in colour, so do stonefishes! One stonefish even looks like a piece of rock covered with small algae.

The three species of the world's most venomous fish, are found from the Red Sea to East Africa and across the Indian Ocean to the northern coasts of Western Australia and Queensland.

Defences on all sides

Stonefishes live in shallow seas, especially where the bottom is coral rock or tidal mud flats. They lie completely still even when anyone goes near them and their only reaction to a foot placed a few inches from them is to erect their spines. The stonefish is virtually invisible against its background and those who are poisoned by it probably never see it. Each of the spines has two poison sacs near its tip. Pressure on this tip makes a sheath covering it slide back leaving the point of the spine bare and exposing the grooves down which the poison flows. Although normally it is the spines on the back that do the damage, if the fish is kicked so that it rolls onto its side, the stonefish can still defend itself—with the anal and pelvic fins.

Fishermen in the Indian Ocean handle stonefishes with great care, especially as the fishes can stay alive 10 hours after they have been taken out of water. Even dead specimens lying high and dry on the beach are still able to inflict a poison wound.

Waiting for food

Stonefishes wait for their food to come to them. Any passing animal not too large to be swallowed is snapped up. They do not seem to be able to see the stonefish, which consequently never lacks a meal. The fish are snapped up in its capacious mouth faster than the eye can see. One moment a fish is swimming towards the stonefish's mouth, the next moment it has vanished, and so far as the human eye can tell, nothing has moved. The poison spines are never used for catching food, but are only used in self-defence.

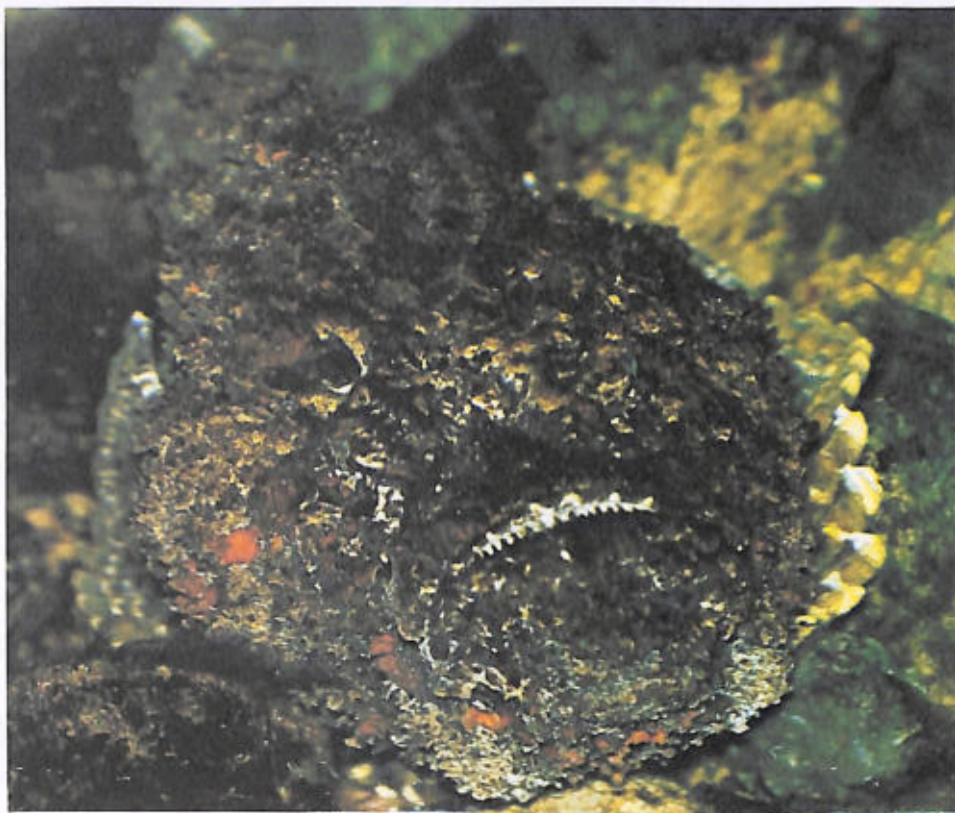
It is hardly surprising, with so dangerous a fish that little is known about how it breeds. Something, however, is known about its enemies—and surprisingly it has enemies. Certain bottom-feeding sharks and rays,

with crushing teeth used for eating crabs and hard-shelled molluscs, occasionally take stonefishes. There is another disadvantage in staying very still on the seabed. In tropical seas there are large sea-snails known as conchs which are both aggressive and carnivorous and stonefishes, especially young ones, fall victim to these.

Thirteen deadly spines

Reports on the effect of the spines on human beings differ. Some suggest that people have trodden on or handled stonefish and been either unaffected or little the worse for the experience. At the other extreme are reports of fatal results. It seems that one can be very slightly pricked in the finger and provided the sheath is not broken, or the wound only shallow, no poison will be injected. It seems also that once the spines have been touched and their poison ejected they are harmless, suggesting that the poison sacs, or the sheath, or both cannot be renewed. By contrast there are authentic cases on record of immediate, extremely painful symptoms, with death following. These speak of excruciating pain with the victim screaming, half mad with agony, collapse, delirium and maniacal ravings. Death follows in about six hours, but if the wounds are not fatal the agony may last up to eight hours then slowly diminish. There has been at least one case in which the patient did not fully recover for a year. In some instances the legs swell to elephantine proportions, there may be large blisters and the skin may slough. Fingers and toes are said to turn black and drop off.

Antidotes, which must be applied quickly, include a weak solution of hydrochloric acid or formalin and permanganate of potash. At the Serum Laboratories in Melbourne, Victoria, in Australia, an anti-venin has been produced.



Helmar Hansen

△ The stone mask of a stonefish *Synanceia horrida*. One of the ugliest and most poisonous fishes, it has been little studied.

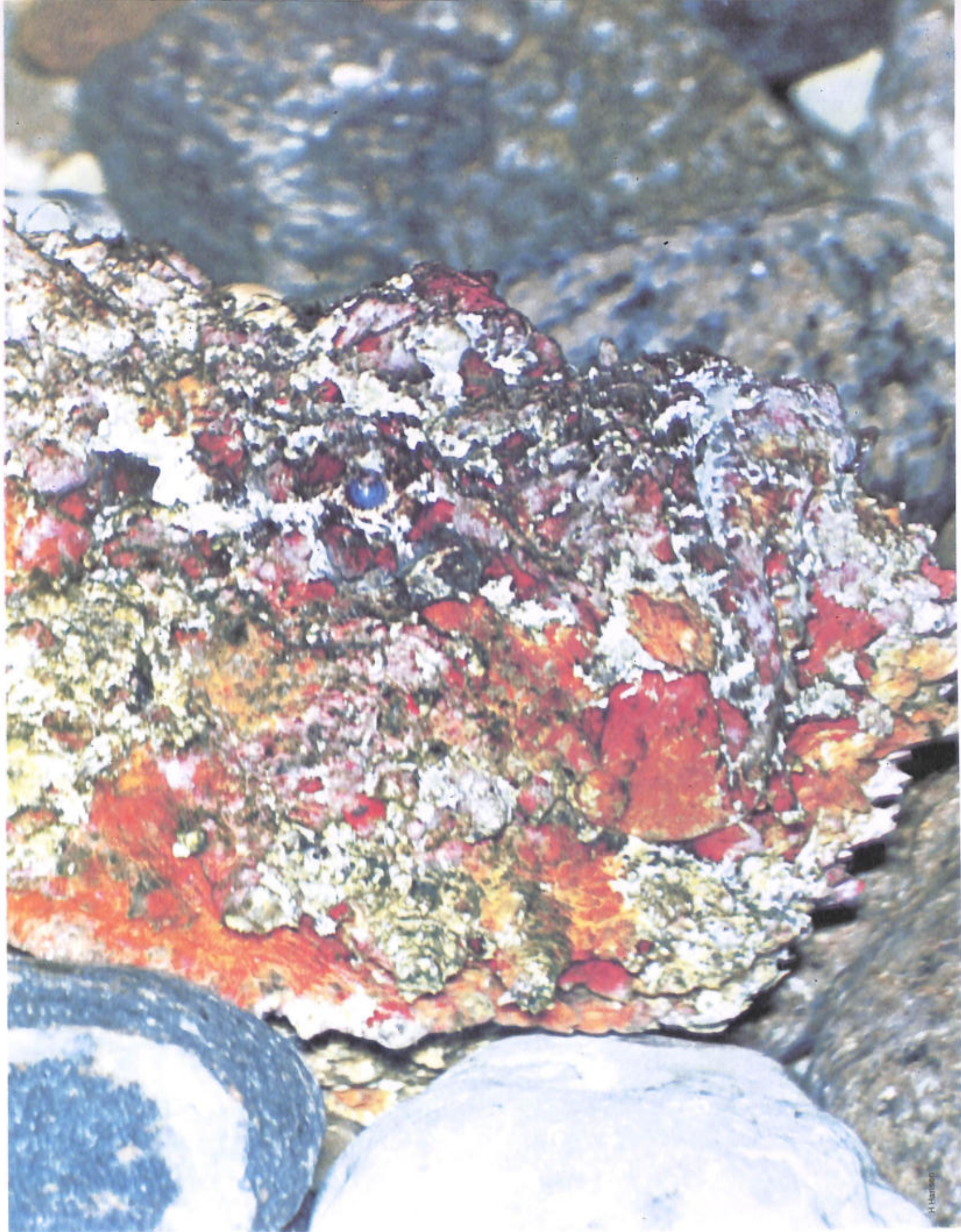
▷ Overleaf: Looking like just another stone on the sea-bed *S. verrucosa* lies in wait, its mouth and eye hardly visible against its cryptically coloured skin. Just visible along its back, 13 spines lie ready to snag an intruder.

Fatality re-enacted

Any suspicion that reports of such grievous symptoms are exaggerated can be set aside in view of the ritual performed by some of the Australian aborigines. It takes the form of a charade, which has been described by Kelvin CB Green, of Australia, and it has been enacted since the time of the Bronze Age in Europe, that is, back in the aborigines' dream-time, their equivalent of times long past. A dancer imitates a man paddling in the tidal pools looking for fishes. He takes short steps, looking to the left, to the right. Then he takes big steps and suddenly lifts one foot, grabs it with a hand, screams and limps away. He sits down, then he lies down, he writhes and screams, while a witch doctor dances around him uttering incantations. Finally, the witch doctor throws up his hands in despair and the 'patient' wails a death song. The interesting feature of this theatrical display is that the dancer carries a clay model of a fish with 13 splinters of wood stuck into its back to represent spines.

class	Osteichthyes
order	Scorpaeniformes
family	Synanceiidae
genus	<i>Synanceia horrida</i>
& species	<i>S. trachynis</i> <i>S. verrucosa</i>







Leaving its watery past behind, a *Perlodes microcephala* nymph before its final moult ($\times 1\frac{1}{2}$).

Heather Angel



A resting stonefly *Dinocras cephalotes*. The forewings are folded round each other on top of the larger hindwings. The stonefly leads a short, inactive life near water where it lays its eggs ($\times 3\frac{1}{2}$).

SG Giacomelli

Stonefly

Stoneflies are little-known insects except to entomologists, and to anglers who use them, or imitations of them, for bait. Artificial stoneflies were first used for fishing in the 15th century. Stoneflies belong to a primitive order of insects, the Plecoptera, which have aquatic larvae. The adults also are generally found near water. They have two pairs of membranous wings, long, thread-like antennae and a pair of segmented appendages called cerci at the hinder end of the body. The name 'cercus' is from the Greek, meaning tail, and in some insects the cerci carry organs of hearing. Stoneflies are weak fliers, and when at rest the large hindwings are folded like a fan and covered by the long, narrow forewings, one of which completely overlaps the other.

Some of the largest stoneflies are big; the North American *Pteronarcys californica* is $3\frac{1}{2}$ in. long. *Perla* and *Nemoura* are the commonest European genera. Dark brown and dull green are the most usual colours, but some of the Australian species are very handsome, with rich red hindwings tinged with purple streaks. One species is jet black with orange on the front of the body.

The larvae are basically like the adults in structure, except that they lack wings, and they have tufts of filamentous gills along each side of the body. Their legs are often fringed with hairs for swimming.

The Plecoptera, a small order of which only 1 500 species are known, is one of the most ancient insect orders; fossil stoneflies are known from the Permian period, about 250 million years ago.

Under stones most of the time

Adult stoneflies are usually found resting on or under stones or on tree trunks near streams. They usually run rather than fly when disturbed. The larvae or nymphs also spend much of their time under stones on the river bed. They have weakly developed biting mouthparts and are said to feed on algae, although probably the adults of many species do not feed at all but only drink. The larvae eat plant food, such as small algae off stones, but larger species also eat the aquatic larvae of other insects.

Aerial egg-laying

The only time to see stoneflies in any numbers on or over water is when the females are laying their eggs. They do this in one of two ways. In some species the female swims on the surface dropping her eggs as she does so. The female of one large species is a strong swimmer and leaves a V-shaped wake behind her. Other females fly over water dipping the tip of the abdomen into the water every now and then; and there is a third group that fly over water alighting from time to time, just to lay eggs and then taking to the wing once more, or they may suddenly fall on the surface with their wings upstretched, releasing their eggs as soon as the abdomen touches the water.

Long larval life

The eggs are dropped into the water in thin membranous packets. The whole pre-adult life is passed in running water, which must be pure and well oxygenated because the larvae depend entirely on their gills for respiration. Larvae of some of the commonest species can easily be found by turning over stones; they live clinging to the undersides. The aquatic pre-adult life lasts at least a year, and sometimes as much as 4 years are passed in the water. During growth the wings gradually develop and there are many moults or ecdyses; up to 33

have been recorded. The larvae remain active at very low temperatures, down to almost freezing in some of the Arctic species. When the larva is ready to moult for the last time it crawls several feet from the water onto a stone or a tree, anchors itself with its hooked feet and splits down the back, releasing the winged adult insect, which takes quite a time to pull itself free.

Profit and loss

Stonefly larvae, also known as creepers by anglers, are of great importance as a source of food for trout and other fish which live in the clean swift streams that they inhabit. Some anglers maintain, however, that they are a mixed blessing because the larger of them feed on the insect larvae which sport fishes, such as trout, also eat. They eat especially the rapacious dragonfly nymphs which, according to Dr HBN Hynes, the stonefly larvae do not see but pounce on as soon as they touch their antennae or cerci, seizing them and worrying them as a terrier would a rat.

Stonefly larvae are also useful as indicators of pollution. Their presence means that a stream is almost or completely free from pollution; on the other hand their absence from apparently suitable waters is a warning that some degree of pollution is probably present, though it may still be far from offensive to the human senses.

phylum	Arthropoda
class	Insecta
order	Plecoptera
family	Perlidae
genus	<i>Perla</i>
family	Nemouridae
genus	<i>Nemoura</i> others

Stork

Storks with their long necks, bills and legs, resemble their relatives the herons and ibises. The plumage is usually black and white. The family includes the true storks and the wood ibises, which are not to be confused with the true ibises. The hammerhead (p. 1146) and shoebill (p. 2241) storks are classed in separate families from the true storks, but the marabou (p. 1548) is a true stork.

The most familiar stork is the white stork that appears often in European legend. It stands nearly 3 ft high and has white plumage with black flight feathers and a red bill and legs. It breeds from Holland and Denmark eastwards to western Russia and Greece, in Spain, Portugal, northwest Africa, Asia Minor and Central Asia. Its range has decreased in this century and it no longer nests in southern Sweden or

Switzerland. Very similar to the white stork is the black stork which is mainly black with white underparts. It breeds in the Iberian peninsula, eastern Europe and across temperate Asia. There are also isolated populations in South Africa and Rhodesia.

Other Old World storks include the mainly black Abdim's stork and the 4 ft high saddlebill, both of tropical Africa. The two openbills are smaller; one lives in tropical Africa and Madagascar and the other in southern Asia. The black-necked stork is found in Africa, Asia and Australia. In the Americas there are two species in the tropics: the jabiru, with a black, naked head, and the maguari stork.

There are four species of wood ibis. In America, ranging from Carolina to Argentina, there is the wood ibis or wood stork with bare, black skin on the head. In the Old World there is the African wood ibis with a red face and in southern Asia there are two painted storks.

▽ Bill clapping display by white storks.





Peter Jackson: Photo Res

Arthur Christiansen



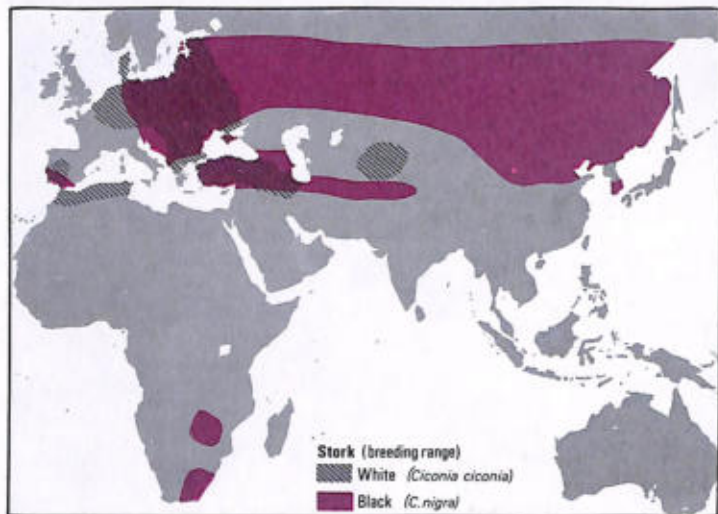


Changing the guard

Many storks nest in tall trees but some nest on cliffs and the white stork and Abdim's stork often nest on buildings. The black stork nests among the branches of tall trees in woodlands, but other storks prefer open country. Where there are plenty of nest sites storks nest in colonies, using the same nests year after year. They are large platforms of sticks, perhaps 6 ft across. When a pair meet at the nest they perform a characteristic display, clattering their bills and bending their necks back until the head is touching the back.

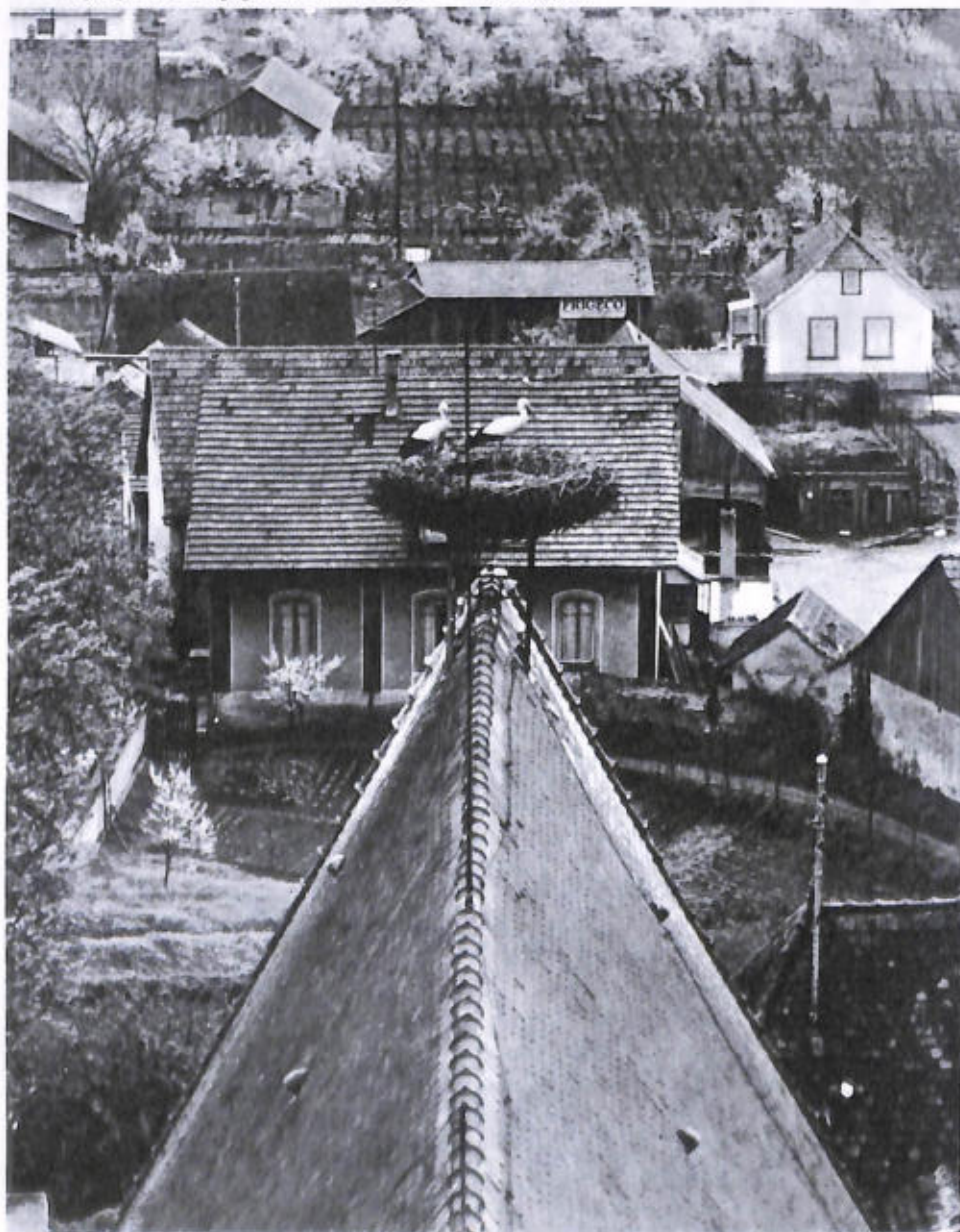
△ *Tree traffic: As a house sparrow takes off, a stately white stork comes in to land with a beakful of nest materials. Nest building is no mean task for a stork, which builds a solid platform of sticks and twigs at the top of a tree — or it may use wicker baskets specially made by man to encourage these birds to nest.*

◁◁ *Undercarriage down: a painted stork about to land in a mangrove swamp.*



KB Newman

▷ The heavily built bill of a saddlebill is used like a heron's.
 ▽ A prosperous pair? White storks have long been regarded as symbols of fertility and good luck in Europe, and as such have been encouraged to nest on houses and churches. The local people of Alsace formed a committee to help the storks, when they were on the decline, building and renovating their nests. Frogs' legs are not served in many restaurants so that the frogs can be left for the storks to feed their young on.



Fred Bruemmer

There are 6–8 white eggs in a clutch. They are incubated by both parents for 1 month. As incubation starts after the first 1 or 2 eggs have been laid and subsequent eggs are laid at 2-day intervals, the chicks hatch out one after the other, and the oldest is quite strong by the time the last emerges. As a result the younger chicks often die unless there is an abundance of food. At first the chicks are given food which is regurgitated by the parents but later whole animals are given straight to them. The young leave the nest when 8–9 weeks old.

Long migrations

Most storks live near water where they wade in shallow pools and marshes in search of food, although the marabou feeds on refuse. The maguari stork and several others feed in dry country such as grassland as well as in water. Storks fly strongly, on broad, rounded, heronlike wings, with the neck extended and legs trailing. Some storks perform long migrations, making use of thermals to soar to great heights.

The migration of the white stork is particularly well known because the flocks of migrating birds are easily seen and large numbers have been ringed. As with migrating birds of prey, long sea crossings are avoided and European storks make their way to Africa across the Bosphorus and the Straits of Gibraltar, soaring high over the land then gliding across the sea. The two streams pass through East and West Africa respectively and it is known that the eastern stream finally ends up in eastern South Africa. A few white storks stay in South Africa and Rhodesia to breed and there is a resident population of black storks nesting on mountain faces in South Africa which is presumably derived from European immigrants that failed to return home.

Enemy of locusts

Storks feed on animals caught in water or on land. In shallow water they catch small fish, pond snails, frogs and large insects. Large insects are also one of their main

items of prey on land. Locusts and grasshoppers are particularly favoured and white storks will interrupt their migrations in East Africa when there is a plague of locusts. Larger land animals such as rodents, young rabbits, lizards and the young of ground-nesting birds are also eaten.

The two species of openbill are so named because when their bills are closed, although the two mandibles meet at the tips, there is a gap between them over most of their length. This is thought to be an adaptation for holding the large water snails which form a major part of their diet.

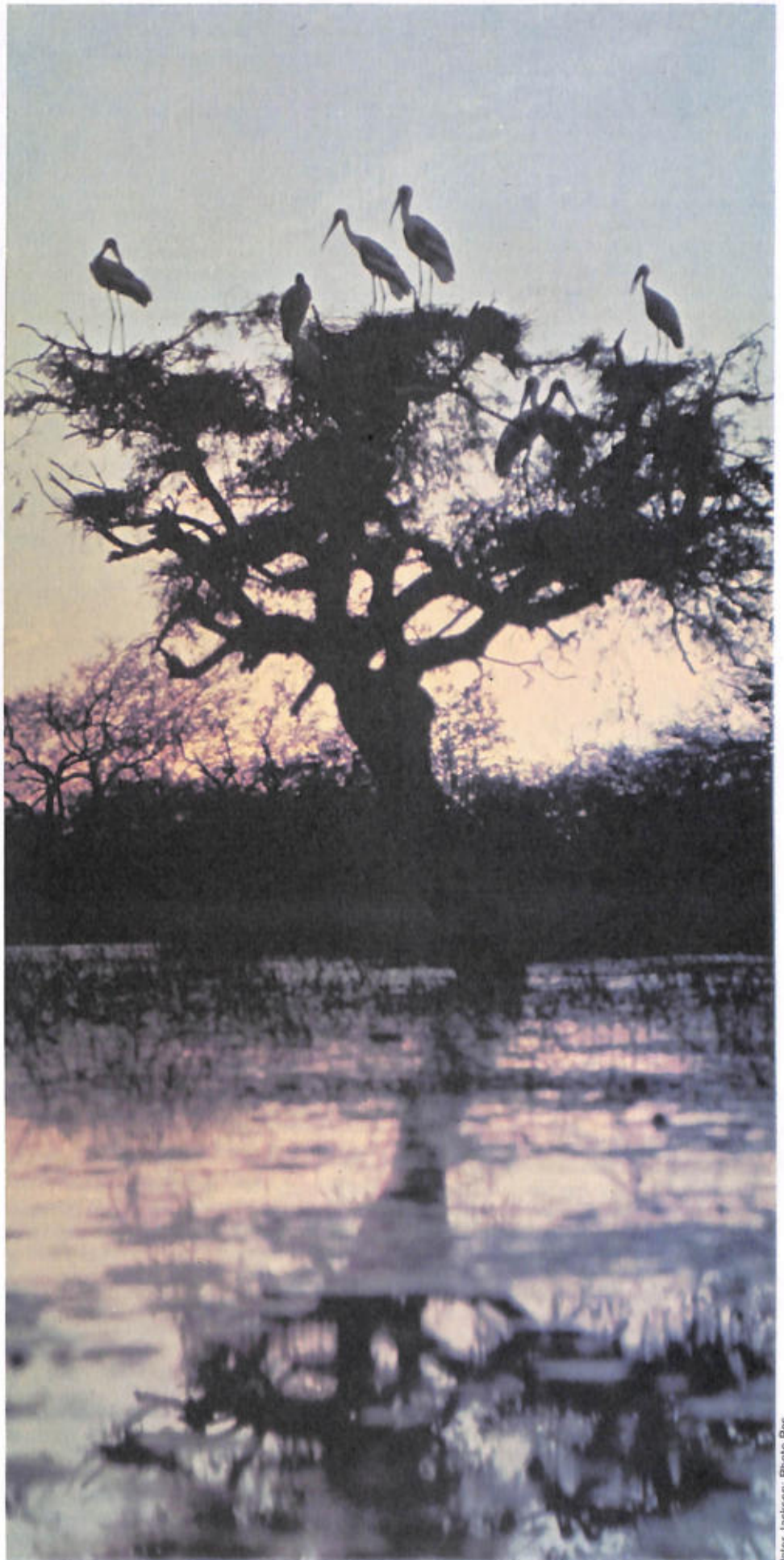
Popular but declining

Because of the white stork's large size and its habit of nesting on houses it has been possible to carry out detailed censuses over a long period. In Germany, for instance, there has been an annual census since 1934 and the census of storks in the Oldenburg district is the longest-running census of any bird. Unfortunately these censuses show that the white stork, like many others, is slowly declining in numbers. Between 1938 and 1954 the European population has been halved and white storks have disappeared from some areas.

The reason for the decline is not simple. For centuries storks have been regarded as symbols of fertility and of good luck, so they were deliberately encouraged to nest on houses. They are, however, shot while migrating, probably in increasing numbers and it is possible they come to grief after eating poisoned locusts. More likely reasons for the steady decline over the century are the drainage of land and the progressively wetter and cooler summers. The latter explains why storks are less common in Holland and Denmark and are declining most in northwest Europe. If this is the case, the decline is natural and will probably not be too serious unless other factors such as death by shooting or poisoning from pesticides get out of hand.

class	Aves
order	Ciconiiformes
family	Ciconiidae
genera	<i>Anastomus lamelligerus</i>
& species	<i>openbills</i> <i>A. oscitans</i> openbills <i>Ciconia ciconia</i> white stork <i>C. nigra</i> black stork <i>Ephipporhynchus senegalensis</i> saddlebill <i>Euxenura galeata maguari</i> stork <i>Ibis ibis</i> African wood ibis <i>I. leucocephala</i> painted stork <i>Jabiru mycteria jabiru</i> <i>Mycteria americana</i> wood stork <i>Sphenorhynchus abdimii</i> Abdim's stork <i>Xenorhynchus asiaticus</i> black-necked stork, others

▷ A group of painted storks stand silhouetted against the sunset in the Bharatpur Wildlife Sanctuary in northern India.



Storm petrel

The name 'petrel' is said to be derived from St Peter in allusion to the ability of some petrels to patter over the surface of the water for short distances. Storm petrels are one of the groups of petrels able to do this and have sometimes been nicknamed 'Jesus birds' for this reason. They are called storm petrels because sailors once thought that their appearance heralded a storm. Another nickname is Mother Carey's chickens, probably derived from Mater Cara, the Virgin Mary.

The 20 or more storm petrels are the smallest members of the order Procellariiformes, which includes the albatrosses, shearwaters and fulmars. Storm petrels can be distinguished from other members of the family by the tubular nostrils on top of the bill being united to form a single opening. Compared with the large albatrosses with their 10–11 ft. wingspans, the storm petrels are midgets, being only 5–10 in. long. They are generally dark, almost black but some have white rumps or white underparts. Three species are grey.

The storm petrels fall into two groups. Those living in the southern hemisphere which have rounded wings, square tails, very slender bills and very long legs, and those living mainly in the northern hemisphere which have shorter legs, longer pointed wings and forked tails.

Among the many species of storm petrel the best known are Wilson's storm petrel which breeds around the coasts and islands of Antarctica and migrates to the North Atlantic as far as Britain and Newfoundland. It is distinguished by the orange webs between the toes. One of the best-studied storm petrels is the British storm petrel which is one of the most restricted, breeding in the North Atlantic and Mediterranean. The majority of the storm petrels are found in the Pacific, in particular around the fertile areas of upwelling currents off Peru and Japan.

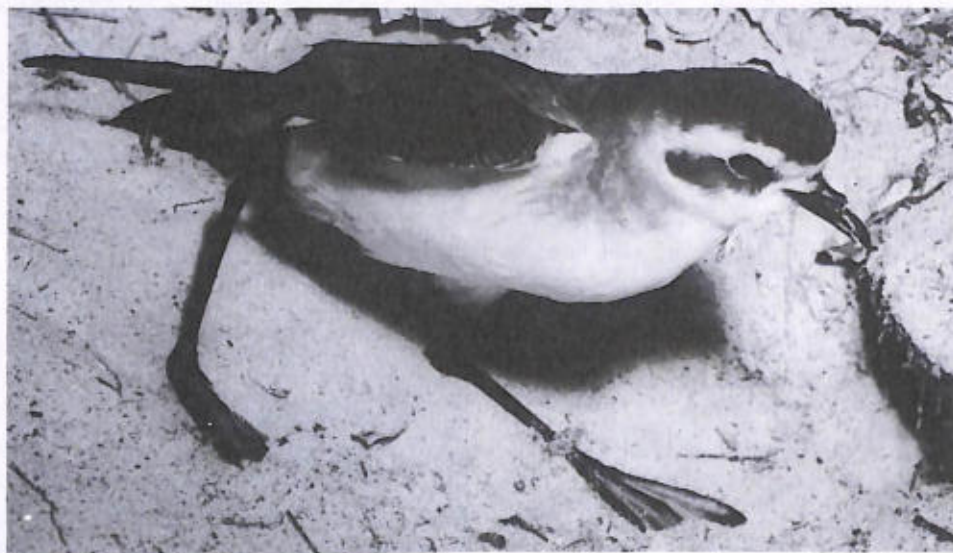
Riding the storm

Storm petrels can sometimes be seen from the shore when their migration routes take them inshore, otherwise they are probably best known as small swallow-like birds that flit to and fro low over the wakes of ships, with an erratic bat-like flight. Often half a dozen or so storm petrels follow a ship, presumably attracted by the small animals thrown to the surface by the churning of the propeller. With the exception of the Galapagos storm petrel, they are not to be seen at their breeding colonies by day. The colonies are on rocky slopes on islands and are only visited at night when masses of storm petrels fly to and fro before landing near their burrows and exchange twittering, crooning calls with their mates within. One storm petrel that does not nest on islands is Hornby's storm petrel that breeds in the mountains of Chile.

A problem facing all birds that spend much of their lives at sea is how to survive storms. The large gliding petrels can, no doubt, run before the wind and are only endangered when blown close to the shore. The storm petrels seem to survive by hugging the surface and keeping to the windward side of the waves. This may seem rather surprising, but on this side of the wave there is an upward air current that assists their flight. The danger period for storm petrels appears to be when the wind changes and runs parallel to the swell. They are then exposed to the full force of the wind without any assistance to keep them airborne except their own strength.

Two ways of feeding

Like other petrels, storm petrels feed on small fish and crustaceans picked from the surface of the water or caught by diving, and on floating scraps left by fishermen,



A white-faced storm petrel *Pelagodroma marina* returns at night to its nest burrow. A bird of the southern oceans, it is characterised by rounded wings and long legs on which it 'walks' along the water.

whalers or predatory animals. The two groups of storm petrels have rather different feeding habits. The long-winged storm petrels skim tern-like over the surface of the water while the round-winged, long-legged storm petrels like the Wilson's storm petrel, 'walk' on the water with their legs hanging down and wings outstretched while they pick up small animals.

Large egg, slow development

The breeding habits of storm petrels follow the same pattern as those of other petrels. The nest is an unlined burrow in soil or in a crevice between rocks, only very occasionally being built in the open, against a rock. Storm petrels nest in colonies; about 200 000 pairs of the Galapagos storm petrel nest in one colony in a lava bed on Tower Island. A single white egg is laid. It is proportionately huge, being up to a quarter of the adult's weight and is incubated for 6 weeks, a very long period. The parents share the incubation, taking 2–5 day stints in turn. The chick is brooded for the first 7 days. It develops very slowly, but stores a large reserve of fat so at its peak it may weigh over half as much again as its parents. This reserve allows the chick to survive

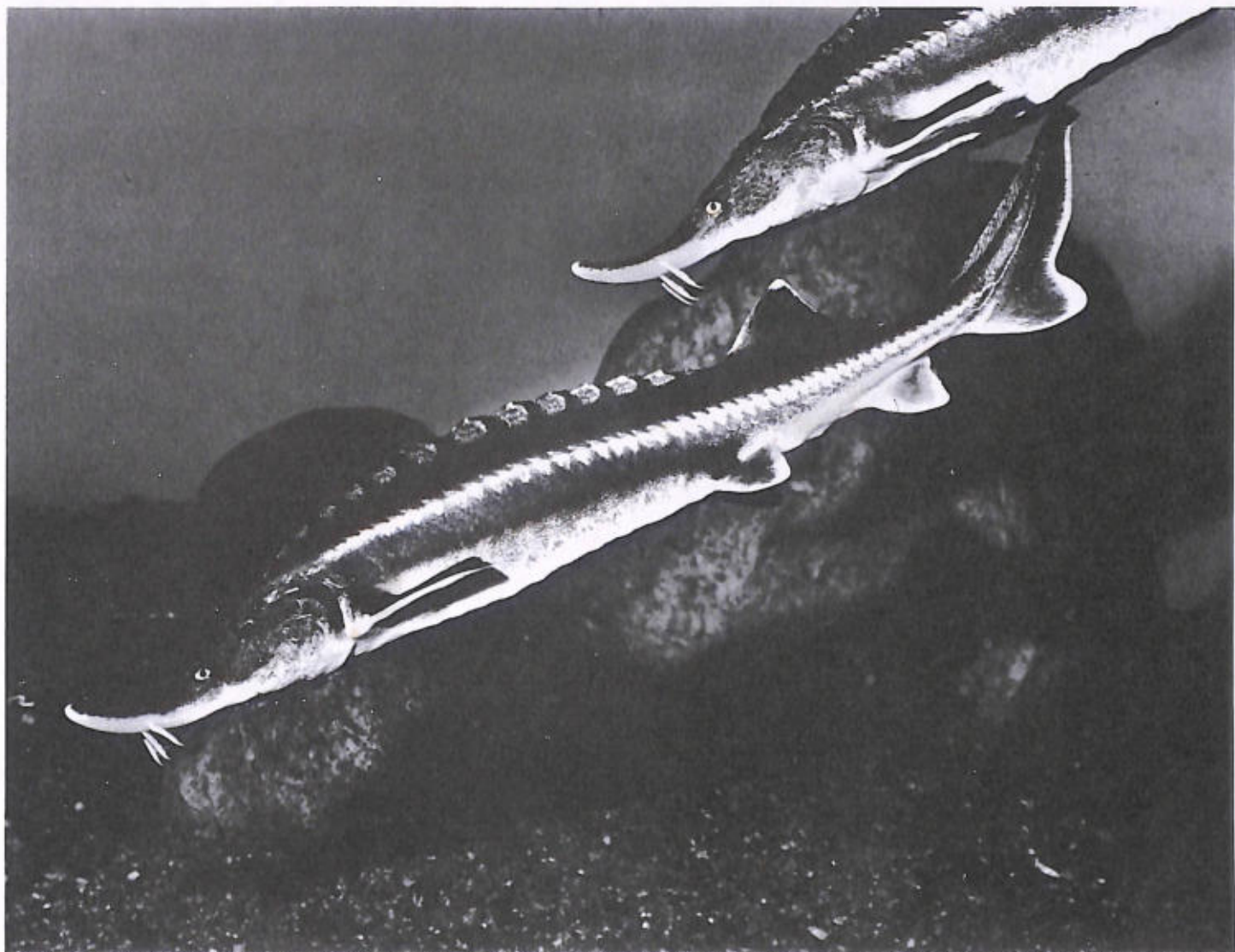
periods when there is a shortage of food and in the case of the Wilson's storm petrel it enables it to survive when the burrow is blocked by snow and the parents cannot find it. The chick fledges when 8–10 weeks old.

Split populations

The Madeiran storm petrel nests on islands in the Atlantic and Pacific Oceans such as Madeira, the Azores, Ascension, Hawaii and the Galapagos. Little was known about its breeding habits until 1964 when it was shown that, on the Galapagos at least, there are two breeding seasons and that eggs are laid from April to June and again from December to January. As the same nests were used in both periods it was assumed that each bird nested twice. Since 1964 the Madeiran storm petrels on the Galapagos have been ringed and the astonishing discovery has been made by Dr MP Harris that there are

two independent breeding populations that nest out of phase. Each population breeds once a year but while one is nesting the other is out at sea. As the food supply around the Galapagos is probably plentiful all the year round there seems to be no reason for the formation of two peaks in breeding. It is not yet known whether young birds join the same breeding population as their parents. If they do this could be the start of the splitting of the Madeiran storm petrel into two separate species, as each population gradually evolves along different lines.

class	Aves
order	Procellariiformes
family	Hydrobatidae
genera & species	<i>Hydrobates pelagicus</i> <i>British storm petrel</i> <i>Oceanites oceanicus</i> <i>Wilson's storm petrel</i> <i>Oceanodroma castro</i> <i>Madeiran storm petrel</i> <i>O. hornbyi</i> Hornby's storm petrel <i>O. tethys</i> Galapagos storm petrel <i>others</i>



Russ Kinne: Photo Res

Despite a sleek and shark-like appearance, sturgeons are slow-moving fish. Here two Volga sterlets cruise gently above the sandy bottom, searching for food. They have poor eyesight and locate their food mainly by touch, using the sensitive barbels seen on the underside of their long snouts.

Sturgeon

The sturgeon is best known as the fish that gives caviare, the luxury food which could soon be a thing of the past. Of greater interest is the fact that the two dozen species are relics of a primitive race of fishes. They are more or less halfway between the sharks and the bony fishes, having a skeleton partly of bone and partly of cartilage. They are shark-like in shape and in the way the hindend of the body turns upwards into the upper lobe of the tailfin. The snout is tapered in the young fish, long and broad in adults, and in front of the mouth, on the underside of the head, are four barbels. The body is scaleless except for five rows of large plate-like scales with sharp points running from behind the gill-covers to the tailfin.

The largest is the Russian sturgeon or beluga (not to be confused with the mammal beluga, the white whale, p. 332), of the Caspian and Black Seas and the Volga, Don, Dnieper and other rivers of that region. It is up to 28 ft long and

3 210 lb weight. One that was 13 ft long and weighed 2 200 lb was known to be 75 years old. It yielded 400 lb of caviare. The Atlantic sturgeon, on both sides of the North Atlantic reaches 11 ft and 600 lb. The white sturgeon of the Pacific coast of North America usually weighs less than 300 lb, but there are records of 1 285, 1 800 and 1 900 lb. The sterlet of the rivers of the USSR is up to 3 ft long. The rest of the two dozen species of sturgeon are all found in temperate waters throughout the northern hemisphere.

Numbers down everywhere

Sturgeons are slow-moving fish, spending their time grubbing on the bottom for food. Some, however, make long migrations. Individuals tagged in North American waters have been found to travel 900 miles. Most species live in the sea and go back up the rivers to spawn. The largest, the beluga, from which half the world's supply of caviare comes, is entirely freshwater. Today all sturgeons are fewer in number than they were a century or two ago, partly from overfishing and partly from the pollution of rivers and to some extent because

hydro-electric schemes have spoilt their spawning runs. In the 17th century a prosperous sturgeon fishery flourished in the New England States of America. In the mid-19th century they were still being caught, for their caviare and for a high quality lamp oil their flesh yielded. A century later the annual catch had fallen by 90%. Sturgeons were once abundant off the Atlantic coast of Europe. Now they are found mainly around the mouth of the Gironde river in western France, the Guadalquivir in Spain and in Lake Ladoga in the USSR. A few only are caught each year around the British Isles and adjacent seas. Around the Black Sea-Caspian area overfishing has brought the sturgeon yield to a low ebb and efforts have been made to establish hatcheries, to rear young sturgeon and so replenish the stock. It has been estimated that as many as 15 000 sturgeons have been caught in these seas and adjoining rivers in a day.

The mud grubber

The name of this fish in several European languages means the stirrer, from the way the sturgeon rummages among the mud for food. This it finds largely by touch, using its sensitive barbels. Sturgeon also have



Heather Angel

A young sterlet barely drifts along, its sensitive barbels tracing food. As it grows the nose broadens and the fish may reach 3 ft in length.

taste-buds, which are normally on the tongue or inside the mouth in other fish, but in the sturgeon are on the outside of the mouth. These help in the selection of food. They protrude from the toothless mouth to suck in the food. Sturgeons are slow feeders and can survive several weeks without eating. In freshwater they eat insect larvae, worms, crayfish, snails and other small fishes. In the sea they take bivalve molluscs, shrimps and other small crustaceans, worms and more small fishes than are eaten in fresh water. The beluga feeds in winter mainly on flounder, mullet and gobies in the Black Sea, and on roach, herring and gobies in the Caspian.

When caviare hatches

Spawning takes place in depths of 18–20 ft. The eggs are blackish, $\frac{1}{16}$ in. diameter and sticky so they adhere to water plants and stones, or clump together in masses. A single female may lay 2–3 million in one season. These hatch in 3–7 days, the larvae being $\frac{1}{2}$ in. long but their first summer they may grow to 8 in.

Use for the swimbladder

Sturgeon have been fished for their flesh and their oil as well as for their caviare. They have also supplied isinglass. This is from the swimbladder and was first named by the Dutch in 1525. They called it *huisenblas* which became anglicized as isinglass. When prepared for use it looks like semi-transparent plastic sheets, and it is almost pure gelatin. It is still used today for special cements and water-proofing materials, but its main use is in clearing white wines, an ounce of isinglass being enough to clarify up to 300 gallons.

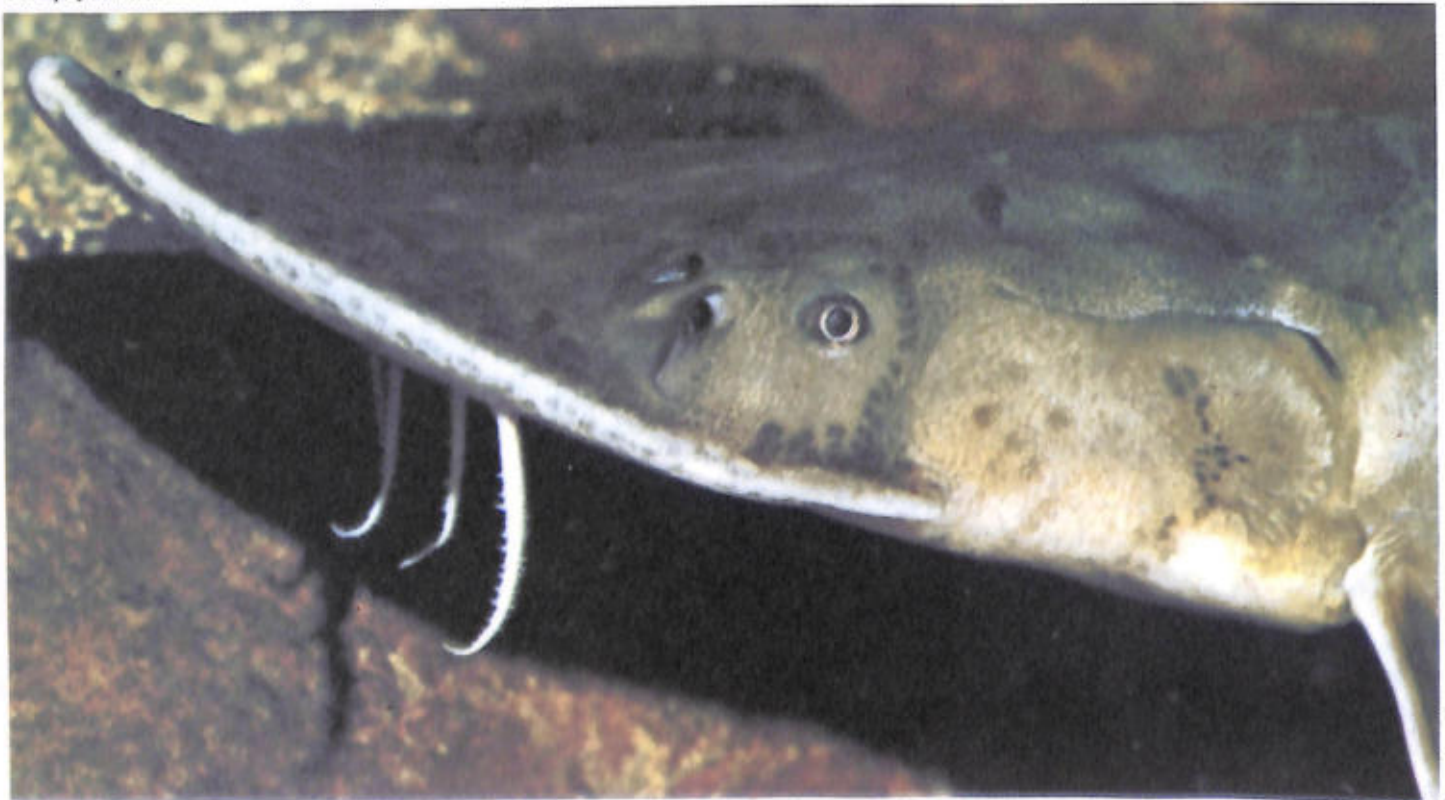
Royal fish

In the days of Ancient Rome the fish, garlanded with flowers, was piped into the banquet carried by slaves similarly crowned with flowers. It was, however, Edward II of England who made it a royal fish. His decree ran: 'The King shall have the wreck of the sea throughout the realm, whales and great sturgeons, except in certain places privileged by the King.' Sturgeon have as-

cended English rivers including the Thames and at one time any caught above London Bridge belonged to the Lord Mayor of London. Henry I is said to have banned even that. Indeed, he forbade the eating of sturgeon at any table than his own. A royal fish indeed: and, in the 1950's, as Sir Alistair Hardy recalls in his book *The Open Sea*: a sturgeon 'died in an excess of misplaced homage, and was covered with distinction, by burying itself in the condenser pipe of one of Her Majesty's aircraft-carriers: HMS *Glory!*'—a worthy burial.

class	Osteichthyes
order	Acipenseriformes
family	Acipenseridae
genera & species	<i>Acipenser ruthenus sterlet</i> <i>A. sturio</i> Atlantic sturgeon <i>A. transmontanus</i> white sturgeon <i>Huso huso</i> beluga others

The aptly named shovelnose sturgeon *Scaphirhynchus platyrhynchus*; the bizarre snout is used to dig snails, shrimps and other morsels from the gravel.



Barry Pengilly

Sugarbird

The sugarbirds of Africa are classed with the honeyeaters of Australasia (p. 1227), but there are doubts whether they are really related because it is difficult to see how honeyeaters could have spread from Australasia to Africa, without leaving representatives in Asia. It is most likely that the sugarbirds have come to resemble honeyeaters through convergent evolution, both groups having similar feeding habits.

The two species of sugarbird are dull brown, relieved only by a yellow patch under the tail. The length is 16-17 in., of which up to 12 in. is long, flowing tail. The female has a rather smaller tail and measures about 11 in. overall. The bill is long and slightly down-curved. The Cape sugarbird, the only species that has been studied in detail, is found in the Cape Province of South Africa and the Natal or Gurney's sugarbird is found in the Eastern Province, Natal, the Transvaal and Rhodesia.

There are other birds that are also known as sugarbirds to aviculturalists. These include the so-called blue sugarbird *Dacnis cayana*, a honeycreeper.



▷ Surrounded by its livelihood, a Cape sugarbird sits on her nest in the branches of a *Protea* bush. Sugarbirds are almost completely dependent on *Protea* and will not leave the area unless there is a lack of food.

Conspicuous defence

Sugarbirds are restricted to mountain slopes where well-known African shrubs of *Protea* are the dominant feature of the vegetation. The only time that sugarbirds leave *Protea* country is when a shortage forces them to search for other sources.

Outside the breeding season sugarbirds are inconspicuous among the dense undergrowth despite their long tails, but throughout the breeding season the male sugarbird makes himself conspicuous as he defends his territory. He spends much of his time perched at the top of *Protea* bushes singing a rather unmelodious song of creaks and clangs. At intervals he performs a special display flight, going from one bush to another with a jerky action that causes the long tail to stream and flutter. This advertisement appears to be sufficient to dissuade other males, as fighting is rare.

Tubular tongues

Sugarbirds have the typical long tongues of nectar-feeding birds (see page 1227) which can be rolled to form tubes through which nectar from *Protea* flowers is sucked. As with many of the true honeyeaters, nectar makes up only part of their diet. Insects and spiders are also eaten. Some, such as ants and beetles, are taken from the ground

and others are caught in the air, flycatcher fashion. Small invertebrates are also collected from among the flowers and leaves of *Protea* bushes. The insects are carried in the tip of the bill and beaten against a branch before being swallowed.

Two broods

The sugarbird breeds during the South African winter, the same time as the flowering season of the *Protea*, when food is most abundant. The female builds the nest and incubates the eggs while the male does no more than defend the territory. The nest is usually in a *Protea* bush. It is made of fine twigs, usually of heather, and dry grass moulded into an untidy cup 6–7 in. across. It is lined with the brown fluff from *Protea* flowers and takes about 1 week to build. The two greyish-brown eggs are incubated for 17 days and the chicks are brooded for 6 days all the time then for a further 2 weeks they are covered only at night.

The male helps feed the chicks but is not so industrious as the female. The chicks are fed on the same food that the adults eat but when very young they receive more nectar. They leave the nest after 18–20 days and are fed for a further 3 weeks, during which time the parents have probably started on the second brood.

Dependence on one plant

There can be few birds that are so dependent on one plant for so many of their needs as the sugarbird is dependent on *Protea*. The basis for this dependence lies in the use of the shrubs as a source of food. This in itself is unusual, especially as much of the food is insects living on the bushes, which presumably could be got from other plants. However, from the dependence on *Protea* for food it is only a short step to nesting in flowering *Protea* bushes. While the young are in the nest the faecal sacs are removed by the parents, as they are in many other birds, but the sugarbirds deposit the sacs on particular *Protea* bushes. A final use of *Protea* is as a bath. After rain, sugarbirds bathe by perching on a stem and flapping their wings against the leaves to send up a shower of water, and also by rubbing their heads against the wet leaves.

class	Aves
order	Passeriformes
family	Meliphagidae
genus	<i>Promerops cafer</i> Cape sugarbird
& species	<i>P. gurneyi</i> Natal sugarbird

A male Cape sugarbird savours the sweet nectar of a *Protea* flower. Sugar birds are similar to honeyeaters in having their stomachs, tongues and slender bills adapted for insect and nectar feeding, but it is not known whether this is due to convergent evolution or if they are true honeyeaters.





Sumatran hare

The Sumatran hare, also known as the short-eared rabbit, is a rare animal found only in Sumatra. It is rather small, only about 14–16 in. long in head and body, with a short inconspicuous tail and remarkably short ears, especially for a hare. It has a soft, dense underfur with longer harsher hairs on the outside. Its coat differs from that of all other hares in its distinctive colouring. Its ground colour is the usual hare or rabbit colour of buffy grey but it is prominently marked with long, irregular bands of dark brown. One of these bands runs down the middle of the back from the snout to the tail, another broad one curves from the shoulder to the rump and from the rump down to the hindleg, while yet another narrow one runs from the shoulder halfway down the upper foreleg. The rump and tail are bright red and the limbs grey-brown. The underside of the neck is dark brown with the remaining underparts being buffy white.

The Sumatran hare is restricted to the tropical forested areas of Sumatra at the foot of mountains and volcanoes.

The closest relative of the Sumatran hare is another short-eared hare, the hispid hare, that comes from Assam on the Indian mainland. It lives in forests and grassy bamboo areas. It is larger than the Sumatran hare, about 18½ in. long in the head and body with a 1 in. tail. Like the Sumatran hare the ears are very short and broad and the

eyes are small. The hindlegs are short and stout scarcely much longer than the forelegs and all the toes are furnished with very strong claws. The coat is unusual in having a short and bristly outer fur beneath which there is a short finer underfur. This hare is uniformly dark brown shading to brownish white on the underparts. Unlike the Sumatran hare the hispid hare digs its own burrows, using its strong claws. It is a solitary animal occasionally living in pairs, and is variously called the bristly rabbit, harsh-furred hare and Assam rabbit.

Little known of habits

Very little is known of the habits of the Sumatran hare. It is apparently nocturnal, sheltering by day in burrows on the forest floor. It does not dig these for itself but uses burrows made by other animals. Unlike the rabbit, it does not live in large colonies. When disturbed it does not have the speed or quickness of movement of other hares. Nothing is known of its breeding habits.

Varied diet in captivity

The Sumatran hare feeds on young shoots and the stalks of leaves of forest undergrowth plants. It sometimes damages the trees by gnawing away the bark. It has been kept in captivity for periods of up to a year, during which time it ate a fairly varied diet of cooked rice, young maize and bread. It would take fruit such as ripe bananas and pineapple but rather surprisingly refused cultivated vegetables, roots and the bark from various trees. The food of the hispid hare consists mainly of roots and bark of trees and shrubs.

Unlike most other hares the rare Sumatran hare has very short ears and does not move fast.

Importance of ears

There are two main points of interest about the Sumatran and hispid hares. The first is that these two hares should be so localized and so rare, as compared with the brown hare (p. 1153) that has such a wide range from Europe to South Africa. The second point is that they should have such small ears. These two may not be wholly unrelated. Allen's law states that there is a shortening of the extremities, and especially of the ears as we go towards the poles from the equator. The best example is the jack rabbit (p. 1313) of North America. Those living in the south have very long ears. These get shorter and shorter for successive species as we go north until in the snowshoe rabbit, the most northerly, the ears are quite small. The large ears give a greater surface for losing heat from the body, an advantage in the warmer latitudes. But the Sumatran and the hispid hares live almost on the equator yet have unusually small ears. This may be because they live in dense forests, in perpetual shade where it is always cool. And this may also explain why they are rare: that they cannot leave this specialized habitat without growing longer ears.

class	Mammalia
order	Lagomorpha
family	Leporidae
genera & species	<i>Caprolagus hispidus</i> <i>hispid hare</i> <i>Nesolagus netscheri</i> <i>Sumatran hare</i>

Sun bear

The sun bear apparently gets its name from the crescent-shaped mark on its chest, the yellow crescent being held to represent the rising sun in eastern folklore. It is also known as the honey bear, Malay bear and bruang. It is the smallest of the bears and one that spends most of its time in the trees. It is only about 4 ft long in head and body with a stumpy 2 in. tail and it stands only about 2 ft. at the shoulder. A fully-grown male may weigh as much as 150–200 lb. It is a stocky animal with short bandy legs which give it a somewhat ungainly appearance when walking. It has large paws with long strong claws. The sun bear has naked soles to its feet, unlike bears that live most of the time on the ground and have hairy soles. The muzzle is shortened and the ears are small and rounded. The smooth, sleek coat of coarse short hair is uniformly black except for the greyish-brown muzzle and the distinctive crescent or U-shaped mark on the chest which may be white, orange-yellow or any shade between. This mark varies in form and may sometimes be lacking. Occasionally the feet are light-coloured.

The sun bear lives in the tropical and sub-tropical forests of southern Asia; in Burma, through southeast Asia, the Malay Peninsula, Sumatra and Borneo. Its range may reach southern China.

▽ Say ah! A lingual loll from a sun bear.



Wolfgang Lummer



Arthur Christiansen

Adept at climbing, sun bears spend most of their time in the tops of trees, often as high as 20 ft.

Expert climber

The sun bear is an expert climber, spending most of its time in the tops of the tall trees. It is mainly active at night and during the day sleeps or sunbathes in a nest formed of branches and twigs at the top of a tree sometimes as high as 23 ft above the ground. Unlike some of the bears in temperate climates the sun bear never 'hibernates'. Owing to the inaccessibility of its habitat it has proved difficult to observe in the wild, especially as it is very cautious and wary, but in captivity it has made an intelligent and lively pet when young. After a few years, however, it may become dangerous.

Honey eater

The sun bear has a very varied diet feeding on any small rodents, lizards, small birds or insects it can find. It will also take fruit and the soft growing part of the coconut palm known as palmito. It will dig out termite or ant nests, inserting its forepaws one at a time and then licking the ants or termites off them. It is very fond of honey and will tear open trees to find the nests of wild bees from which it extracts the honey and grubs with its long extensible tongue. Most people writing about the sun bear mention its long tongue but say little more about it. In fact most bears, and certainly the brown bear, can push the tongue out to a surprising length even when merely yawning.

Two cubs in a litter

Not much is known of the breeding habits of the sun bear. In view of the latitudes in which it lives there may be no regular breeding season. Cubs have, however, been recorded on several occasions during August. There are usually two cubs in a litter, born on the ground well-hidden in the vegetation on the forest floor. They remain with their parents for some time.

An attractive pet

One of the few detailed accounts of the sun bear has been given by James Alexander Hislop in *Natural History*, 1955. 'Bertie', a tiny sun bear cub, was apparently abandoned by its mother in Malaya when 2 weeks old and was adopted by Hislop and his family who found him an engaging and

good-natured pet. For the first few weeks the cub was quite blind and would scramble about on the floor bumping into anything in his way. He took easily to bottle feeding and while sucking his bottle made noises rather like a duck grubbing in the mud. He was extremely fond of bread spread with honey, syrup or jam and would come and beg for it in the evening. When contented he would sit for hours sucking a hind paw while making a strange happy humming sound just as a human baby will suck its thumb before going to sleep. After sucking his paw Bertie would fall asleep, always on his belly, head tucked under forepaws.

There are several accounts of bear cubs, of other species, hand reared, and all indicate that in many ways bear cubs are very like human babies. One outstanding trait is that when feeding or resting they are apt to develop mannerisms or tricks of behaviour which they insist on carrying out. Then suddenly they will drop them. One cub, for example, insisted for a short period in swinging one leg while taking its bottle, refusing to feed if not able to do this.

At 6 months old Bertie was taken to King George V National Park so that he might in time return to the jungle which was close by, but he would never wander for more than two days and always came back to his enclosure. In the Park he soon became an adept tree climber and made platforms of twigs and branches in the same way as the sun bears in the wild make their sleeping nests. He discovered that decayed tree stumps and logs contained ants and other insects and his powerful claws would demolish the rotten wood while his long tongue lapped up the ants.

At the age of nearly 2 Bertie weighed over 120 lb and measured 3 ft 10 in. from head to tail. From then on his size and weight became too great to keep him as a pet and his owners were reluctantly compelled to send him to a zoo.

class	Mammalia
order	Carnivora
family	Ursidae
genus	
& species	<i>Helarctos malayanus</i>

Sunbird

Sunbirds are the Old World equivalent of the American hummingbirds. They are not related and their flight is not so rapid as the hummingbirds', but they do feed on nectar and small insects. The main similarity is in the plumage. That of the males is generally brilliant with a metallic lustre or velvety sheen. Many males, and some females, have epaulettes of bright feathers on the 'shoulders' which are raised during displays.

The 100 species are all small, the largest measuring only 8 in. from tip of bill to tip of tail, while most are less than 6 in. long. The sunbird family are found over most of the warmer forested areas of the Old World. Half the species are found in tropical Africa and the rest live in southern Asia from Israel through India and the East Indies to northern Australia and the Philippines. Sunbirds are also found on the Seychelles and on the remote islands of Aldabra and Assumption in the Indian Ocean. Some of the sunbirds in southeast Asia are known as spiderhunters, but this name does not seem to be particularly related to their feeding habits.

Following their food

Sunbirds live in forests, bushy cultivated land and savannah. They are also found well up mountains near the timberline. Here they have been found roosting, sometimes

Sunbirds of the savannah: scarlet-chested male and dull female sample some Clerodendron nectar.



Nesting in gossamer: Malayan scarlet sunbird

communally, in holes in trees or abandoned nests, apparently to keep warm during the cool nights.

Sunbirds feed on insects and nectar. They can be seen flying about in parties but they are not really gregarious, in the sense that the party stays together as a social unit. Rather, the sunbirds come together at plentiful sources of food, and move around the country as different flowers come into season. Some of the insect-eating sunbirds have, however, been seen banding into parties and working through the vegetation together driving insects before them. Some sunbirds follow a regular track in search of food supplies. An example is the pygmy long-tailed sunbird that moves south from the Sudan to Zaire, staying there for a few months. While it is there the plants of the savannah flower and the sunbird raises a brood, although it depends less on flowers than its longer-billed relatives.

A striking feature of the sunbirds is their tameness. One story is told of an expedition collecting specimens on Mount Ruwenzori in Uganda. One of the party had the utmost difficulty in shooting a beautiful scarlet-tufted malachite sunbird for his collection because it perched on the barrel of his gun.

Nectar and insects

Sunbirds resemble the flowerpeckers (p. 937) and honeyeaters (p. 1227) in their feeding habits and the specialised structures adapted for them. For example, all three groups feed on either nectar, insects or both. They have special tongues to get nectar from the bases of long, thin flowers and a digestive system that enables large quantities of liquid to be passed rapidly through.

The tongue is divided into three or four flaps at the tip which helps 'spoon up' the nectar and for most of its length the tongue is rolled over on each side to make two tubes up which the nectar is sucked. The muscular gizzard which is used to crush up hard-bodied insects has the entrance and exit near each other so it can be shut off from the rest of the digestive system allowing nectar to run straight into the intestine from the gullet.

Nectar is obtained by the bird perching on a twig next to the flower or hovering in front of it like a hummingbird. When the flower is too large for the sunbird to reach the nectar from either of these positions, it tears a hole in the side of the flower near the base and pokes its bill in. Except when the sunbird 'cheats' like this, pollen is rubbed onto its head. Later, this is transferred to the stigma of another plant, fertilising it. Among the plants pollinated this way are the tropical mistletoes. These plants rely on sunbirds, flowerpeckers and honeyeaters for pollination and would die out without their unknowing assistance.

Aggressive territory battles

The male sunbirds are extremely aggressive during the breeding season, chasing intruding males well away from their territories. Some males sing fairly well but others have only an uninspiring twitter. They do not usually help the females build the nests or feed the young, yet the pair often stay together all the year round.

The nest is a bag-like structure of roots and grasses matted and woven together hanging from a twig. There is an entrance on one side, sometimes covered with a porch. The nest is often suspended from a bare branch with no attempt at concealment. Some species habitually nest near the nests of wasps, apparently gaining protection from their presence. Most spiderhunters make a cup-shaped nest which is sewn to the underside of a leaf by fibres or cobwebs, knotted on the upperside. The entrance to this kind of nest is in the side of the cup.

The female broods the 1 or 2 eggs for a fortnight and the chicks stay in the nest for nearly 3 weeks before travelling about in family parties.





◁ A malachite sunbird contemplates a large flower of *Protea cynaroides*. Nectar is usually obtained by the bird hovering or by perching on a nearby twig, but if the flower proves too big the sunbird will tear a hole in the side.

♀

Sunbirds unlock flowers

In the entry for flowerpeckers the possible evolution of the pollination of flowers by birds is discussed. Nectar eating apparently arose from feeding on insects living in flowers, and flowers evolved copious supplies of nectar to attract the birds. The relationship seems to have reached its zenith with the sunbirds and the flowers of some African mistletoes. In some of the mistletoes the flower will not open without the aid of a sunbird. In one species of mistletoe the flowers are opened by the sunbird inserting its bill in a slit in the side of the corolla. The tube then bursts open and the anthers spring out scattering pollen onto the bird's feathers. In another the anthers snap off and fly out. The flower of an Indian species has to be squeezed gently at the tip by a sunbird before it will open.

These mechanisms are quite remarkable. Their function is presumably to ensure that as much pollen as possible gets lodged on a sunbird where it will have the greatest chance of being transferred to the stigma of another flower. But it does seem that this is one of the instances of nature producing an over-elaborate device.

class	Aves
order	Passeriformes
family	Nectariniidae
genera & species	<i>Aethopyga mystacalis</i> scarlet sunbird <i>Aracnothera longirostra</i> little spidebeak <i>Chalcomitra senegalensis</i> scarlet-breasted sunbird <i>Hedydipna platura</i> pygmy long-tailed sunbird <i>Nectarinia johnstoni</i> scarlet-tufted malachite sunbird others

Sunbittern





Sunbittern

The sunbittern is a large and little-known inhabitant of tropical American forests. It is related to the coots, cranes and bustards rather than the true bitterns of the heron family. It is, however, heron-like in appearance, about 18 in. long, with a long slender neck, small head and long bill. The bright orange legs are also long and slender and the toes are unwebbed. The wings and tail are broad. The plumage is soft like that of an owl and is mainly brown and grey with black bars and spots. The crown of the head is black and two white streaks run across the face. There are two broad black bands across the tail. The bill is black on the upper mandible, yellow on the lower. When a sunbittern opens its wings a pattern of chestnut and orange becomes visible on the back with white and black patches on the wings.

Sunbitterns are found from southern Mexico to Bolivia and central Brazil.

- ◁ Overleaf. A sunbittern flutters playfully up a waterfall revealing its soft, owl-like plumage.
▽ Out on a limb: an unusual photograph of a brooding sunbittern on its nest of moss and mud.

Sunset display

Sunbitterns, like herons, live singly or in pairs along the banks of rivers or in swampy woodland and wade slowly through the shallows in search of food. Captive sunbitterns have been described as standing with their bodies swaying from side to side in the same manner as bitterns, reputedly to make them less conspicuous among the waving reeds. They also spend a considerable time motionless with the neck withdrawn as herons do. Sunbitterns are reluctant to fly preferring to walk and to swim across streams. When disturbed, however, they fly into trees. Their flight is very quiet, presumably because of the soft plumage, and their broad wings give them the appearance of gigantic fluttering moths. Sunbitterns are usually silent but sometimes they utter quiet whistles or rattles.

The display of the sunbittern is most spectacular. The forepart of the body is lowered while the head is raised and the wings are spread with the rear edges raised and the tail fanned and brought up, so that the whole of the beautifully patterned plumage is displayed in a semi-circle. The bright chestnut and orange of the back and wings have been described by Alexander Skutch

as looking like 'a sun darkly glowing in a sunset-tinted sky'. During the display a harsh rattle is given. This display is used during courtship and also as a threat, being sometimes directed at a man.

Sunbitterns feed on insects, crustaceans, small fish and other small animals found in shallow water along the banks. Their feeding behaviour is very much like that of herons; they stalk slowly or stand motionless then suddenly shoot out their necks and grab their prey in the dagger-like bill.

Nests rarely seen

Very few sunbittern nests have been found in the wild. Alexander Skutch describes one which consisted of a 12in. mass of decaying leaves, twigs, moss and mud, lined with green leaves and perched on a 2in. branch. A tree is the usual place for a sunbittern to build its nest but they may build on the ground.

The first record of the nesting behaviour of the sunbittern was the description given of a pair that nested in London Zoo in 1865, and a century later it is still the most detailed account, although sunbitterns have since nested in other zoos. The pair built their nest of straw, grass, mud and clay on a specially provided platform, 10 ft up. The first egg was found broken under the nest but a second was laid shortly afterwards and was incubated by both parents for 27 days. The chick was like that of a snipe and was fed by both parents on food carried in their bills until its wing feathers had grown enough for it to fly to the ground, at the age of 21 days. The parents continued to feed it and 2 months after it had hatched another egg was laid and incubated mainly by the male while the female continued to feed the original chick. In the wild the normal clutch seems to be 2 eggs.

Mixed crowd

The order Gruiformes, to which the sunbittern belongs, contains some unusual birds. There is the large family of rails, some of which are flightless, the button-quails in which the female plays the leading role in courtship, the mesites of Madagascar which are probably flightless, the cranes, finfoots and the bustards. Some of the Gruiformes resemble birds outside the order, such as the stork-like kagu, the ibis-like limpkin and the heron-like sunbittern. Despite a variety of external form and habit the gruiform birds have many similarities in the form of their skeletons and muscles. One habit which is, however, very common in the group is that of nesting on the ground and producing chicks that can walk soon after hatching. The sunbittern is an exception because it nests in trees and although its chicks are hatched with a coat of down and appear well-developed, they are fed in the nest for some time.



class	Aves
order	Gruiformes
family	Eurypygidae
genus	
& species	<i>Eurypyga helias</i>

Sunfish

There are two kinds of sunfish. One lives in the sea and gets its name from the false idea that it comes to the surface to bask in the sun and is dealt with on page 1740 under ocean sunfish. The other is a freshwater fish whose behaviour is influenced by the sun.

Freshwater sunfishes are North American. The two dozen perch-like species are variously called basses, crappies and blue gills, as well as sunfishes. They usually have a long continuous dorsal fin, the front part of which is spiny. In a few species there is a slight notch where the front and hind parts meet, and the rear portion is higher than the front part. Several species have a so-called ear flap, where the operculum extends backwards. This is often made more obvious by its colouring: white-edged in the long-eared sunfish, sometimes with dots of red on the flap itself, or with a blood-red blotch as in the pumpkinseed or common sunfish. The smallest are the banded and the mottled sunfishes, never more than 1½ in. long. The pygmy or blue spotted is 3½ in. long. The largemouth bass may be 2½ ft long and up to 25 lb.

Sunfishes are most common in the central and eastern regions of the United States. The only species native to the west of the Rockies is the Sacramento perch, although others have now been introduced into the rivers of California.

Susceptible to change

Most sunfishes live in clear lowland rivers and lakes, especially where there is a sandy bottom, and particularly in flowing waters with quiet weedy shallows. The smaller species form small shoals, the larger are solitary and predatory. All are very sensitive to changes in their environment, especially to sudden changes of temperature. The red-bellied sunfish, for example, winters in the deeper water of lakes and migrates into shallows to spawn when the temperature of the water is 10°C/50°F. They are, however, strongly influenced by sunlight, possibly largely through its effect on temperature. On a dull day they are not very active. Thus, their first act on coming to a spawning ground is to dig a redd. On dull days the sunfishes do no more than station themselves over their redd, fanning it with their fins, so preventing it from silting up. On a sunny day the shadow from a passing cloud is enough to make them stop all activities.

Swimming animals eaten

Sunfishes feed on swimming animals, rarely touching anything on the bottom. The smaller species eat insect larvae, especially midge larvae, and small crustaceans. The larger sunfishes eat small fishes.

Male guards nest

The chief interest in sunfishes is in their breeding behaviour. The male digs the redd, a shallow depression in the sand, by using

his tail as a fan. He then entices the female into this to lay. The redd is usually in a spot sheltered by water plants or large stones, and the male may use bits of plant to reinforce the nest. Also, the smaller the fish the shallower the water it would choose to nest in. In some species there is no great difference between male and female, but in some the male is more brightly coloured. The female lays about 1 000 eggs which tend to stick together in clumps. They also stick to sand grains which helps to hide them. Once the female has laid, she is driven away by the male who guards the nest, fanning with his fins to aerate the eggs, and chasing away any intruder. The eggs hatch in 3–6 days. At first the fry lie in the redd, later they cling to the water plants, but the male remains in attendance for 2–3 weeks, shepherding the babies into the redd each night. One reason why the male must guard the eggs and young is that other young sunfishes will eat them.

Can't bear vibrations

The choice of the nesting site seems to depend on vibrations in the water. As they come into breeding condition the sunfishes that have been living in schools disperse, as if unable to bear each other's company. The reason seems to be that they are

through the movements a courting female would make, the male occupying the nest courted it. Yet when a mirror was put into the water the male displayed vigorously at his image, presumably recognizing it as a male by the movements it made. To be on the safe side, tests were made with plasticine models and individuals of the same species, to see if smell had any effect. So long as the correct movements were made with the model the male would attack it or court it, according to whether it was made to move like a rival male or like a courting female. Colour must have some importance but these experiments showed that the kind of movements were equally important.

Cuckoo minnows

A kind of cuckoo behaviour is shown by an American minnow *Notropis umbratilis*. When a male green sunfish is establishing his nest the minnows assemble above him. When a pair of sunfishes lay their eggs, the minnows lay theirs in the same nest. Tests suggested that the minnows are first attracted by the movements of the male sunfish. For example, if the male is taken away, even although his nest is still there, the minnows also depart. The stimulus that makes the minnows spawn is something given out into



Black-banded sunfish *Mesogonistius chaetodon*: a popular aquarium fish in Europe and America.

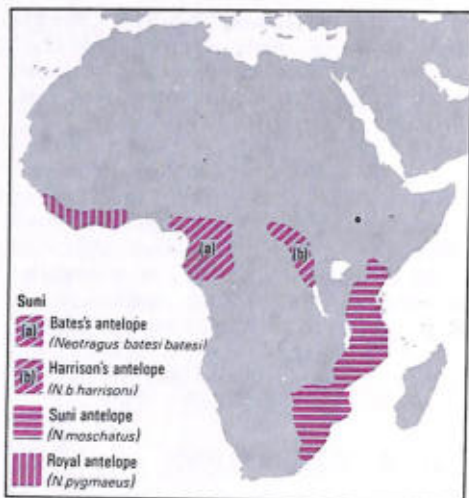
intolerant of vibrations set up by their fellows in the normal course of moving about. This was put to the test. Various objects were put into the water to act as baffles. It was found that as soon as a baffle was placed between two males, cutting off their vibrations, they were prepared to nest much closer together.

Colours and movement

One of the most colourful species is the pumpkinseed sunfish. The male is grey-green with 5–8 pearly bars on the flanks, or in older individuals the bars may be greenish-blue. There are reddish or orange spots on the head, orange-red on the throat and belly and an orange blotch on the black 'ear flap'. The gill cover itself is green with red lines and spots, and the fins are green to yellow. To test the use of these colours a male sunfish was anaesthetized and held near another male with a nest in an aquarium. The colours apparently meant nothing to it; and when the anaesthetized male was manipulated so that it went

the water from the milt or the ova of the sunfish. Even when in an aquarium with no sunfish nor the sunfish's nest, minnows will spawn if the fluid from the male sunfish's milt or from the female sunfish's ovary is put into the water. It is probably detected by smell.

class	Osteichthyes
order	Perciformes
family	Centrarchidae
genera & species	<i>Archoplytes interruptus</i> <i>Sacramento perch</i> <i>Elassoma evergladei</i> <i>mottled dwarf sunfish</i> <i>E. zonatum</i> banded dwarf sunfish <i>Enneacanthus gloriosus</i> <i>pygmy or blue spotted sunfish</i> <i>Lepomis auritus</i> red-bellied sunfish <i>L. gibbosus</i> pumpkinseed sunfish <i>L. megalotis</i> longeared sunfish <i>Micropterus salmoides</i> <i>largemouth bass, others</i>



Suni

The suni and its relatives, the smallest of all the antelopes, are incredibly slender and dainty. They are closely related to the steinbok and grysbok, but are smaller, with the horns in line with the face instead of upright. Like the steinbok, there is a gland in front of the eyes, but this is not in a deep pit. There are also glands between the hoofs but in the steinbok these glands open into long clefts while in the suni they open by just small holes. Like their relatives, however, the sunis have no knee-tufts and small lateral hoofs or none at all. Only males have horns.

The true suni, or Livingstone's antelope, is 13–15 in. high with strongly ridged horns from 2½–5 in. long. There are no lateral hoofs. The coat colour is reddish to greyish brown, slightly speckled; the underside is white. The suni is found all along the East African coast from Zululand in the south to the Tana River, Kenya, in the north, and reaching inland as far as Kariba and Ngorongoro. It also occurs on the offshore islands of Zanzibar and Mafia, but not on nearby Pemba.

Bates's dwarf antelope is smaller, only 12 in. high, with horns not more than 2½ in. long. It has rudimentary lateral hoofs. The coat colour is brown, with the underside usually only slightly whiter. It is found from the lower Niger river to northern Gabon; a different subspecies known as Harrison's dwarf antelope, which is darker above and more white below, occurs in the eastern regions of Zaire. There appears to be no dwarf antelope between these two areas.

The smallest of all is the royal antelope, 10 in. high or less, with horns only 1½ in. long. Its hindquarters, as in many small ungulates, are higher than the forequarters. The lateral hoofs are absent, but there is an area of naked skin in the site where they would be in the suni. Its coat colour is bright reddish fawn, with white chin, throat, chest and belly. The royal antelope is found along the West African coast from Sierra Leone to Ghana.



A shy couple: suni, among the smallest of antelopes, are just over a foot in height.

EL Burton

Shy high jumper

All three species live in dense cover. The royal and dwarf antelopes live in humid tropical forests, the suni in drier thicket country interspersed through the eastern savannahs—so its distribution tends to be rather local and broken up. Little is known of their way of life; however, they are rarely seen in numbers above two, and generally they seem to be solitary.

These tiny antelopes seem to be more grazers than browsers, although Bates's dwarf antelope is said to eat the tops of peanut plants. Suni have been seen to feed on roots and tubers, which they presumably dig up with their sharp hoofs. Suni spend the day lying in thick cover, coming out into more open clearings to feed at dawn and dusk. Royal antelope are largely nocturnal animals.

When an intruder, such as man, approaches a suni, the animal lies hidden, blending perfectly with the background, until the enemy is perhaps as little as 10 yd away. Then it jumps up and dashes away, twisting and dodging as it goes. But after running for 300 yd it stops, stands still and looks back. When a suni hears or scents anything unusual it gives a short bark and whistling alarm call.

Royal antelope are even more shy and equally secretive. With their long hindlegs they are good jumpers, as much as 9½ ft being recorded for a single jump.

Bubbling courtship

Suni, at least, live in a seasonal environment and breed at set times of the year. In South Africa the young are born during the month from mid-November to mid-December. The male 'herds' the female, chasing her around and making a 'bubbling noise' as Astley

Maberly describes it but whether they mark objects with the face-glands, or 'embrace', or court with the leg-beat is quite unknown.

African Br'er Rabbit

These remarkable little antelopes are among the least-known of all ungulates; even specimens in museum collections are rare. A royal antelope lived in the London zoo from April 1962 to December 1968. Royal antelopes have in the past been confused with chevrotains, which vie with them for the title of 'smallest ungulate', as well as with the much larger blue duiker. In West Africa, particularly in Liberia, the royal antelope is a figure of fable, a smart little fellow of wits, often compared with Br'er Rabbit in the southern United States—it may be that there is an actual connection one way or the other, since the present day population of the coastal region of Liberia is descended from freed slaves, and this is in any case an area from which many slaves came in the first place. Royal antelope are not regarded as very rare, although hunted for their skins. Indeed, Rahm reports that they are still common in the Ivory Coast. But suni are now extremely scarce in Zanzibar.

class	Mammalia
order	Artiodactyla
family	Bovidae
genus	<i>Neotragus moschatus suni</i>
& species	<i>N. batesi batesi</i> <i>Bate's dwarf antelope</i> <i>N. batesi harrisoni</i> <i>Harrison's dwarf antelope</i> <i>N. pygmaeus royal antelope</i>

Surfperch





Edmund Hobson

Surfperch

A hundred years ago the surfperch fishes were described as extraordinary not only because they bear their young alive but because the 'babies' are sexually mature almost as soon as they are born. Surfperch are very like the freshwater perch except that the dorsal fin, spiny in front and soft-rayed in the rear half, is continuous instead of being in two distinct parts. There is also a groove in the back on either side of the dorsal fin. Their bodies are compressed from side to side and their lips are fleshy. They are mainly silvery, darker on the back than the belly, and at the front edge of the anal fin in the male is an intromittent organ for transferring the milt to the female. Surfperch, also called seaperch or surf-fishes, are 5–18 in. long according to the various species.

Most of the 25 species come into the surf to drop their young; for the rest of the time they live in shallow seas. The pink seaperch is unusual in living at depths of about 600 ft, others may be found at times in tide pools, and the freshwater tule perch lives in the Sacramento River in California. Except for two species living off Japan and Korea, all seawater surfperch live off the Pacific coast of North America, from Alaska to southern California.

Infantile mating

Surfperch are in every way quite ordinary perch-like fishes, feeding on small crustaceans and other small invertebrates, except for their breeding, which goes on more or less throughout the summer. In some species at least, the males are slightly smaller than the females and somewhat darker in colour during the winter. The actual act of copulation has not often been observed, but it is known that it takes place, in most species, in shallow water and that the young are born the following summer at the surface. The main point is that it takes place within two days of birth, the males being sexually mature at birth, the females maturing soon after, and pairing then takes place. This is probably unique, certainly among the higher animals.

Living in the ovary

Another unusual feature is that the ova remain in their follicles in the ovary until they are fertilised. In most viviparous fishes they are shed into the oviduct before being fertilised. Moreover, although sperm are introduced into the females at copulation, the ova are not fertilised until the following spring, the sperm remaining dormant until then. The ova are small and contain little yolk but the embryos into which they grow are nourished by a fluid given out from the ovary. Once the fertilised ova drop from their follicles into the cavity of the ovary they develop rapidly and the embryos grow a gill opening. Cilia on this drive a current of liquid food through the gill and into the embryo's digestive tract, which at this stage

◁ Overleaf: pearly striped *Embiotica lateralis* among sea anemone *Metridium dianthus*.

◁ A dull coloured *E. jacksoni* against a blending background of seaweed off California.

is no more than a simple tube showing no sign of the future stomach and intestine. Later when the fins have developed, outgrowths from the dorsal and anal fins rich in blood vessels, absorb nourishment. The liquid also contains the oxygen necessary for respiration. At a later stage some of the surface cells of the walls of the ovary drop away and are consumed by the growing embryos, as are any sperms left over.

Packed like sardines

The number of young varies with the species and with the size of the mother, but usually there are between 3 and 80. In the shiner or yellow-banded seaperch, for example, the number is 3–20, exceptionally 36. An 8 in. mother would probably have 20, each about 1½ in. long, tightly packed within the ovary.

Commercial fishery

Some of the larger surfperch are fished commercially or for sport. The annual catch for the market is about 150 tons in the United States, and surfperch are also caught for market around Japan and Korea.

The amazing perch

The first reports about the viviparity of surfperch were sent from California, in 1853, to the celebrated Louis Agassiz, professor at Harvard University. He published an account of these, calling them extraordinary fishes and, as so often follows from a fresh discovery, attention was focussed on them and they were written about in scientific journals all over the world. Perhaps, because so many remarkable things have been discovered since then, the surfperch do not excite us so much today. Yet everything about them is extraordinary. There are plenty of freshwater fishes that bear living young, but very few marine fishes, other than the surfperches. Few bony fishes copulate, other than surfperches. We have to go to bats for examples, among vertebrates, of delayed fertilisation such as is found in surfperches. Then, it is most unusual for development of embryos to take place in the cavity of the ovary. It is most unusual among viviparous fishes for the embryos to be nourished other than through a yolk sac. And then we have the unique situation of the young, or at least the young males, becoming sexually mature before birth. Perhaps it is this early maturity of the young surfperch that accounts for their being born in the surf—in a place likely to be reasonably free of enemies at the time they are pairing.

class	Osteichthyes
order	Perciformes
family	Embiotocidae
genera & species	<i>Cymatogaster aggregata</i> shiner <i>Hysterocarpus traski</i> tule perch <i>Zalemibus rosaceus</i> pink seaperch others

Surgeonfish

Most surgeonfishes are very colourful but they cause difficulties for those trying to name them because of the way they change colour. They are called surgeonfishes because they carry lancets that can cut one's flesh as cleanly as a surgeon's scalpel.

Surgeonfishes are deep-bodied fishes, flattened from side to side, and almost oval in outline except for the tailfin. They have small rough scales and small gill openings. The tapering snout ends in a small mouth which has a single row of teeth in each jaw, used for scraping food off coral. Both dorsal and anal fins start just behind the head and end just short of the tail. The pectoral fins are relatively large. The 'lancets' are small, extremely sharp, bony keels, one on either side near the base of the tailfin. In some species they are jackknife hinged, the hinges being at the hind end. When not in use the lancet lies in a groove or a sheath. The lancets are used as weapons by the fish and can be quickly erected and thrust forward when needed. Some members of the family have several lancets on each side. The lancets are sharp and can cut badly anyone that handles the fish carelessly. The 200 species of surgeonfishes grow to 2 ft in length at the most. Their colours, while varied, have the subdued quality of pastel shades.

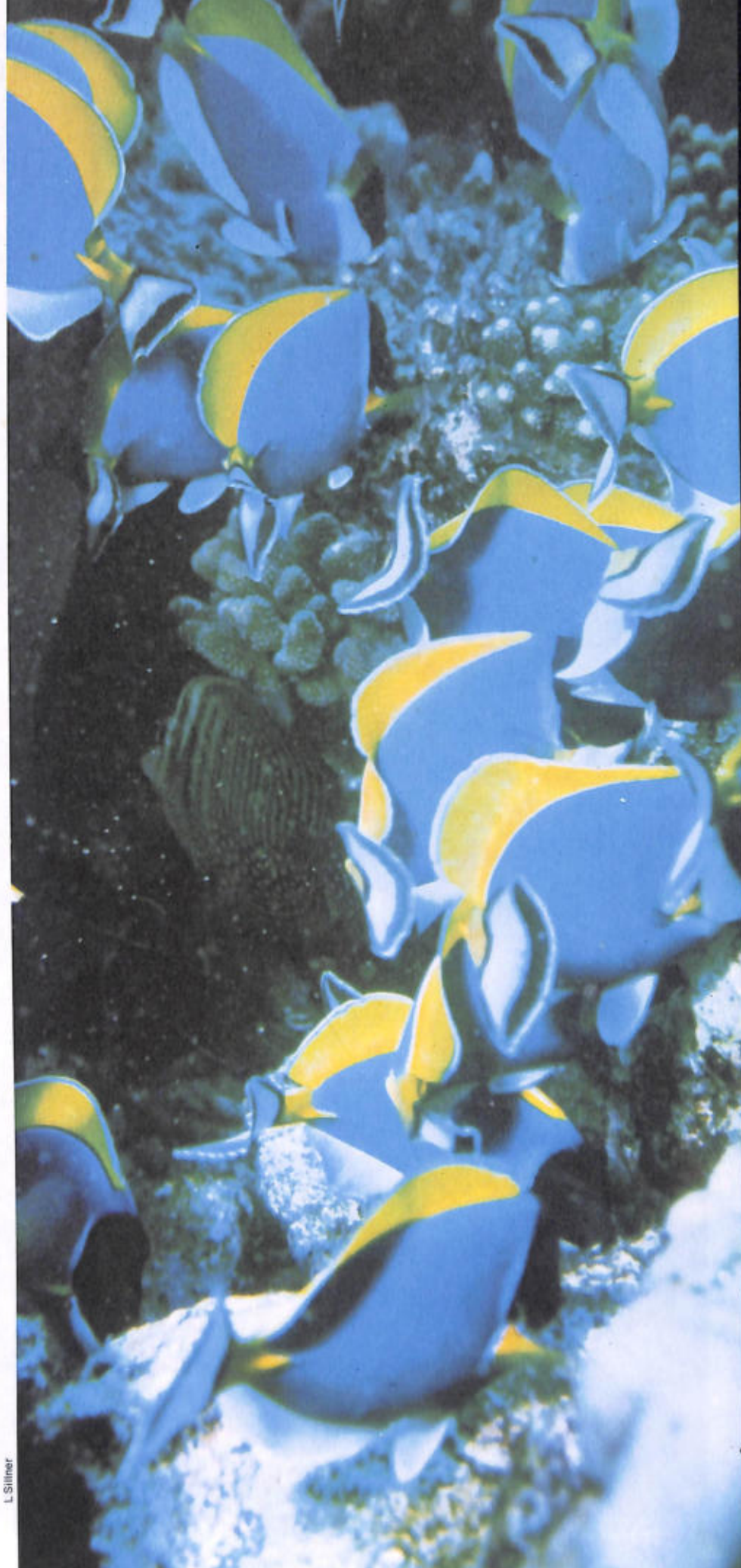
Turncoats all

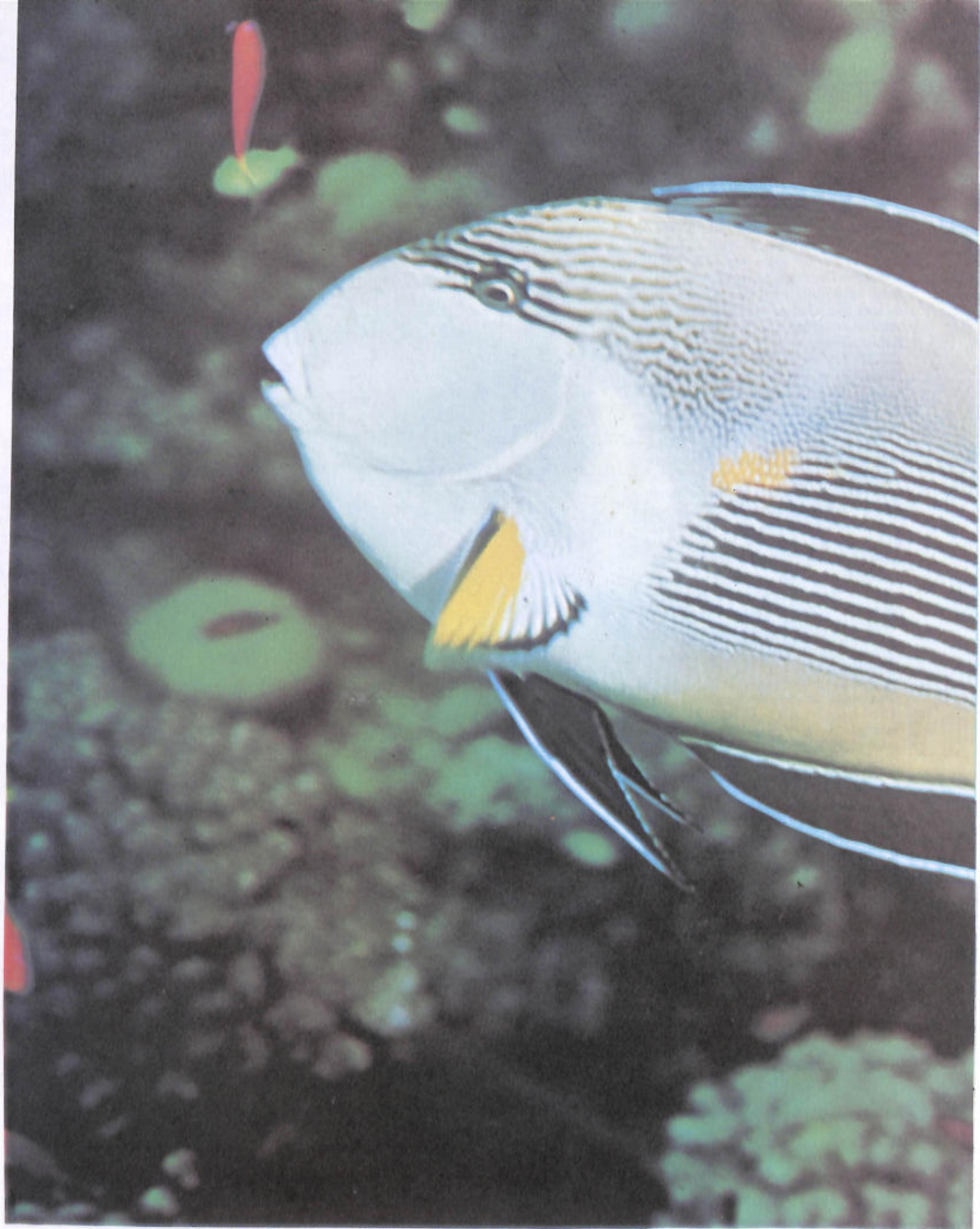
Surgeonfishes live in shoals on and around coral reefs, so are restricted to warm seas. They crop coral for small algae, possibly eating portions of small invertebrates living on the coral, but these are taken only accidentally. Surgeonfishes range from Madagascar across the Indo-Pacific to Hawaii. A common species is the yellow surgeon which can be found in two colour phases, one yellow, the other brown. The first is found only around Hawaii, the other throughout the Indo-Pacific. The five-banded surgeonfish of the Indo-Pacific, up to 10 in. long, has a dark apple-green body with dark brown vertical bars. It is also known as the convictfish. The blue tang is blue when adult, but bright yellow when immature with a blue margin on the dorsal and anal fins. Marked changes in shape occur in some species, like the bumphead surgeon which has a smooth forehead when young but develops a large bump on its head which, with a large eye either side of it, makes it look grotesque.

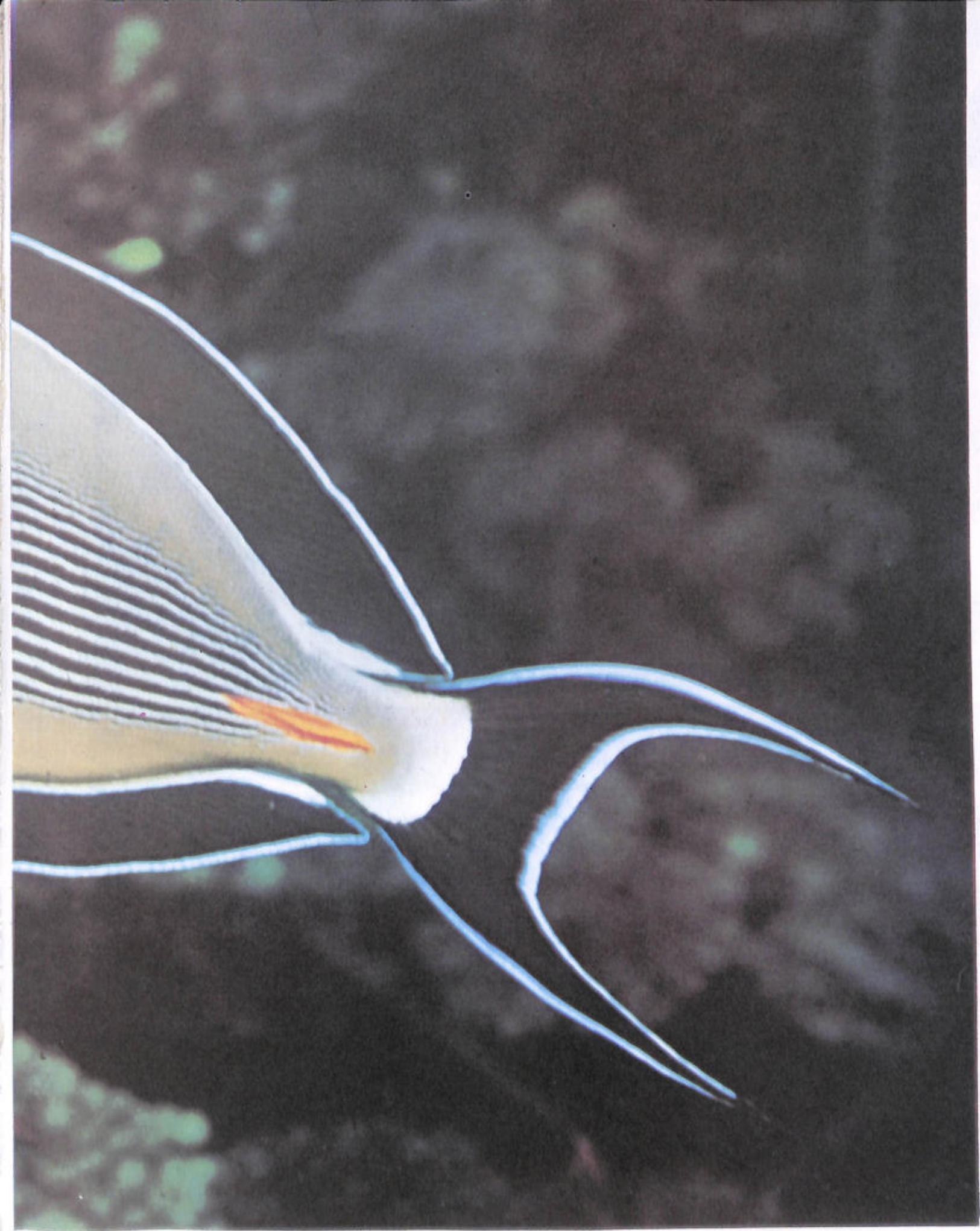
Well-armed juveniles

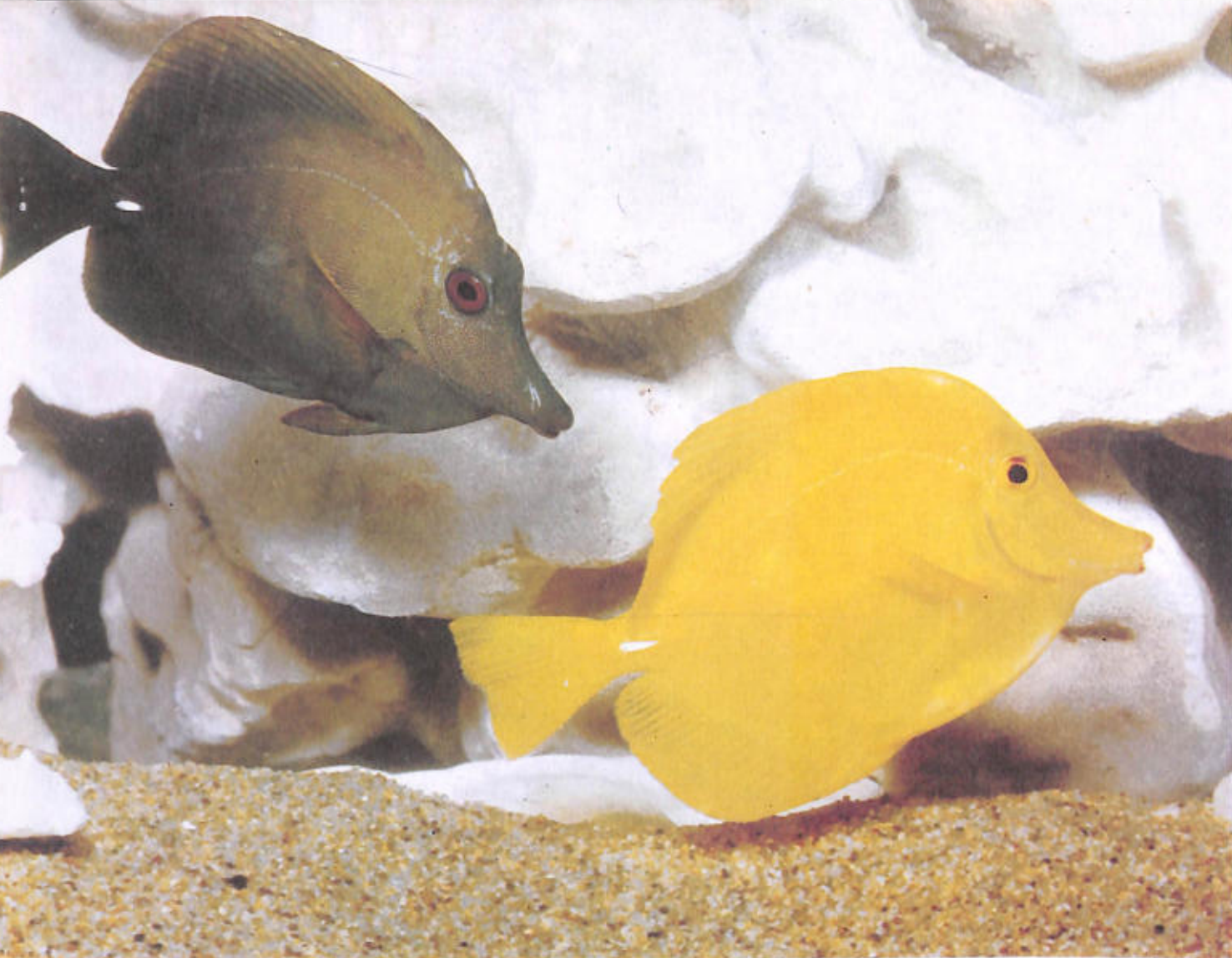
The convictfish has a separate race in the seas around Hawaii, recognized by a dark sickle-shaped mark on the base of each pectoral fin. Most surgeonfishes breed throughout the year but the Hawaiian race breeds only from December to July. Each female lays 40 000 eggs which are about $\frac{1}{4}$ in.

▷ A harmony of blue and yellow curves—a shoal of *Acanthurus leucosternon* browse a coral reef.









John Tashjian at Steinhart Aquarium

◁ Overleaf: A study in black and white an *Acanthurus*. △ The yellow surgeonfish occurs in two distinct colour phases as shown by these specimens in the aquarium. The yellow phase is found only around the Hawaiian Islands, the brown phase throughout the Indo-Pacific.

diameter and contain an oil droplet that buoys them up to the surface. The larvae hatch in 26 hours and are just under $\frac{1}{2}$ in. long. They float upside down at the surface for another 16 hours, until the contents of their yolk sacs are half used up. Then they begin to sink gradually, and as they do, they start swimming. At the end of four days, the larva has grown a swim-bladder and is able to swim about and capture its food of plankton.

The elongated, almost tadpole-like larva changes after 2½ months into a diamond-shaped fish, flattened from side to side with long dorsal and anal fins. The second spine from the front of each fin is long, toothed throughout its length and venomous. The spine of the pelvic fin is similar in shape and also poisonous.

The early development of the convictfish is probably not typical since the doctorfish of Florida to Brazil passes through the larval form in a matter of days. One feature of the surgeonfish larva is the great change that takes place in the intestine. The larva feeds on small plankton animals, the adult is wholly or almost entirely vegetarian. As the larva changes to the baby fish with something of the form of the adult, the intestine grows, increasing by approximately three times its original length.

Sting in the tail

The names surgeonfish and doctorfish must owe their origin entirely to the shape and the sharp edges of the lancets on the tail. There is nothing beneficent in these. On the contrary, they are weapons of offence comparable to the sting of the tail of the stingray. An outstanding feature of the stingray, the flat fish related to the skate, is that it swims with its pectoral fins and the tail is reserved almost entirely for lashing to bring the sting into action. The surgeonfishes, so different in shape, also swim with their pectoral fins, not with the tail like other fishes of their shape. As they are mainly vegetarian they do not need speed for catching food, and they have formidable weapons of defence, so they do not need speed to escape from enemies. They swim with a rowing action of their pectoral fins, the tail fin at most making leisurely waving movements. When necessary, however, they thrash the tail violently from side to side, the lancets sticking out on either side, and giving an enemy sharp, slashing cuts. As a result other fishes give them a wide berth, except for certain kinds of cleaner fishes, which remove the parasites from their skin. When a surgeonfish feels the need for this it swims over to where

the cleaner fish has its station and changes colour. In the case of the Atlantic ocean surgeon, the one on which the best observations have been made, the surgeonfish changes to a dark olive brown instead of the normal reddish purple. It is probably a signal, a sign of peace, an indication that it will not slash its benefactor. Surgeonfishes may change colour more often than we suspect. There is a record of one surgeonfish, in dispute with another, which became white in the front half and dark in the rear half; it stayed like this for half an hour—looking like a new species!

class	Osteichthyes
order	Perciformes
family	Acanthuridae
genera & species	<i>Acanthurus caeruleus</i> <i>blue tang</i> <i>A. bahianus ocean surgeon</i> <i>A. hepatus doctorfish</i> <i>A. triostegus convictfish</i> <i>Naso tuberosus bumphead</i> <i>Zebrasoma flavescens</i> <i>yellow surgeon</i> <i>others</i>

Suricate

All mongooses make delightful pets but the suricate or meerkat of South Africa, one of the smallest mongooses, is particularly attractive because of its habit of sun-worshipping. It is slender in build being only 10–14 in. long in head and body with a tapering tail 7–10 in. long. Its coat is long and soft, light grizzled grey, with thick dark reddish underfur. Its back is marked with black transverse bars. The head is almost white, the ears black and the tail yellowish with a black tip.

The suricate is confined to southern Africa, mostly south of the Orange river, and is found principally in the dry, sandy plains where there is little vegetation other than low grass. It is also found in some rocky areas.

▷ Suricates are odd creatures looking like a cross between a lemur, a dog and a rather thin raccoon; the two here are lazily stretched out sunbathing, a habit they indulge in as much as they can. The long hair, that is alternately striped with light and dark bands, masks the slender bodies of these animals.

▽ Sun-worshipping in a clover patch: sitting up, alert, on their haunches adults and kittens alike enjoy basking in the sun. Suricates are sociable animals and generally live in colonies. Their activities are almost entirely limited to the daytime but even then they do not wander far from their burrows.



Peter Johnson



Ch. epia

Sociable and friendly

Suricates come out soon after sunrise to feed and return at dusk. They generally live in colonies, in burrows which they dig for themselves although in rocky areas they may live in crevices among the rocks. An average colony consists of 24 or more individuals. They will sometimes live with the ground squirrel *Geosciurus inauris* and with the yellow mongoose *Cynictis*. Suricates are energetic diggers and the burrows which are close together have numerous entrances leading to passages 3–6 in. wide and go down to as deep as 10 ft underground.

During the day suricates may be seen basking in the sun either lying down or sitting up on their haunches facing the sun – sun-worshipping. They do not usually wander far from their burrows and consequently soon use up the local food supplies. The whole colony will then migrate, sometimes to as much as a mile away. Being a sociable animal the suricate makes a tame and affectionate pet, adapting itself easily to domestic surroundings and conditions. In South Africa they are often kept around the house or farm to kill rats and mice.

Suricates have a large vocabulary of sounds ranging from grunts of satisfaction when they are feeding to repeated short and sharp barks when alarmed.

Like all mongooses, suricates indulge in play especially when young, but they seldom play after they are 2 years old.

No threat to poultry

In the wild the suricate feeds mainly on insects, spiders and centipedes and the bulbs or tubers of certain plants. It will also catch lizards, birds, rats and mice and will eat the eggs of birds and reptiles. It is especially fond of avocado pears. Like other mongooses it will kill moderate-sized snakes and is said to be highly resistant to the venom of the black mamba. Unlike other mongooses there have been no records of it raiding poultry runs. Indeed, a tame suricate was once found in a hen's nest, on friendly terms with the chicks.

Suricates are easy to feed in captivity. They will take any meat, poultry, eggs, cheese and milk as well as a wide variety of fruits and vegetables.

Boisterous courting

Suricates are thought to breed throughout the year and before mating there is some semi-serious, boisterous fighting. If the female repulses the male he may grasp her firmly by the neck, without, however, hurting her. After a gestation period of about 11 weeks 2–4, rarely 5, young are born in a nest in the burrow. Their eyes begin to open on the 10th day and by then they are completely covered with hair but they do not grow their full adult coat for at least 2 months. When the kittens are tiny, the mother suricate carries them about either by the head or the neck or by the middle of

the body. When they get larger she may take hold of them by the skin of the thigh. After weaning, the young are fed only by the female while the male defends the family, but he also takes his part in family life by grooming the young.

'Stiff-legged rock'

Because of the open nature of the country in which they live and because they are active during the day, suricates must constantly guard against attacks from hawks and eagles. At the first sight of a hawk the suricate gives its alarm bark and the bird will be watched by all the suricates until it is out of sight and the danger has passed. When young captive suricates saw an aeroplane for the first time they reacted exactly in the same way as if it had been a hawk, sight seeming to be more important to them than the sound of the aircraft's engines.

If a suricate encounters a potential predator on the ground, such as a strange dog, it erects its hair and then advances towards the enemy in what has been called a 'stiff-legged rock'. The legs are stretched, the back arched and the tail is held stiffly erect with the head slightly lowered. Although advancing at a gallop it covers little ground because it jumps stiffly in the air at each step. It must present a somewhat alarming appearance to any predator especially as it keeps up a continual growling. If the enemy still approaches, the suricate will spit and may even attempt to bite—a dog has turned tail after being bitten on the nose.

If the enemy is not too close and danger therefore not too pressing, the suricate may indulge in displacement digging, carried out with both front feet together, while watching the enemy all the time.

Learning by example

One of the most interesting features of parental behaviour observed in a captive suricate is the feeding of the young after weaning and their introduction to solid food. The mother does not feed them with solid food until they have emerged from the nest and accompany her on foraging expeditions. When she finds something to eat she will run up and down with it in her mouth as if trying to get the young ones to take it and they will snatch it from her rather in the same way as fox cubs. If they do not take it she will lay it down in front of them. Even in captivity where there is plenty of food the mother still behaves in this way, so the young can be introduced to a strange food. For example, one litter when first offered bananas failed to recognise them as food, never having seen them before. Therefore they showed no interest in them. When, however, the mother was given a banana to eat they immediately rushed up and snatched it from her and soon became extremely fond of the fruit.

An alert mother suckles one of her kittens. There are usually 2–4 in a suricate litter.



class	Mammalia
order	Carnivora
family	Viverridae
genus	
& species	<i>Suricata suricatta</i>

Surinam toad

The Surinam toad is very flat, has remarkable breeding habits and has long been kept in aquaria as a pet. It is about 4 in. long, the male being smaller than the female. Its flattened body is rather like a square pancake, its head is small and triangular and on the upper lip near the eyes are flaps of skin or short tentacles. Its skin is slippery and covered with small warts. Like all members of its family, the Surinam toad has neither tongue nor teeth and with them it is sometimes referred to as a tongueless frog. Although it has very small eyes it can see in all directions, an advantage for any animal in detecting its enemies. The toad's feet have long fingers and toes but only the hindfeet are webbed; it uses its front feet mainly to capture food and to push it into its mouth. It is a blackish-brown colour above, which makes it almost invisible in the black mud of the streams and pools where it lives. Its underparts are paler brown spotted with white or sometimes whitish with a dark brown stripe along the belly. The whole effect makes for a well-camouflaged toad.

The Surinam toad is found in Brazil and the Guianas.



Constance P. Warner

Skilful scavenger

The Surinam toad's flat, flabby body looks most ungainly if it is taken out of water but in water the toad swims strongly and gracefully using its powerful hindlegs. It lives its life almost entirely in the water, scavenging in the mud for any small aquatic animal, dead or alive, that its long slender fingers can sweep up. At the tip of each finger is a cluster of glandular filaments, sensitive organs of touch, that help the animal to find its food even in black mud or when the stream or river is thick and silty.

The Surinam toad does not hibernate but during dry weather it will bury itself in the mud sometimes in large numbers.

Surinam toads live quite well in captivity but they do not often breed under the artificial conditions of an aquarium.

Carrying her eggs on her back

The Surinam toad is noted chiefly for its remarkable breeding habits. Mating takes place soon after the start of the rainy season. After uttering a series of strange metallic ticking calls the male grasps the body of the female with his arms. Just before he does this the female's oviduct grows out and, in amplexus, the male presses it beneath his body and over the female's back. This helps to squeeze out the eggs onto the thick, spongy skin on her back. In all, about 60 eggs are laid in this way and pressed into her skin by the male.

Grotesque gripper: a Surinam toad follows its fingers. The filamentous tips (above) are tactile organs which find food in its normally opaque home.



John Tashjian at Steinhart Aquarium

When the last has been laid the male swims away but the female stays quietly resting while her oviduct goes back to normal and disappears into her body. The skin of her back slowly swells, a hole forms round each egg and, most astonishing of all, a lid forms over the top, so that each egg lies in its own pocket, the whole of the female's back looking rather like part of a honeycomb. Although the female now looks fat and clumsy it does not seem to inconvenience her in swimming around and catching food.

As with other frogs and toads the eggs hatch into tadpoles but all this takes place inside each small pocket, where the larva remains until the whole of the metamorphosis is completed. Then, 3–4 months later the lids of the pouches open and the young toads emerge and swim around freely.

▽ Last egg trailing from her extraordinarily extensible oviduct, a female Surinam toad rests after amplexus, with the majority of the eggs firmly placed in the thick, spongy skin of her back by the pressure of the male.

Birth of legends

The Surinam toad used to be called the pipa in the 18th century, when it was already well known in western Europe. The people of that time were puzzled to know how the toadlets got into the mother's back. A Mr Ferman who claimed to have been an eyewitness of the event, told them that 'the eggs are generated within the female, who, when they have attained the proper degree of maturity, deposits them on the ground. The male amasses together the heap, and deposits them with great care, on the back of the female, where after impregnation they are pressed into the cellules, which are at that period open for their reception, and afterwards close over them.' That, indeed, was the accepted explanation until less than 50 years ago. Mr Ferman added: 'In this singular production of young, the pipa seems to bear considerable analogy to the different species of opossum.' This was almost prophetic for it was from this same part of the world that an even worse piece

of misinformation came and was perpetuated even more firmly. Moreover it concerned the opossum Mr Ferman mentioned.

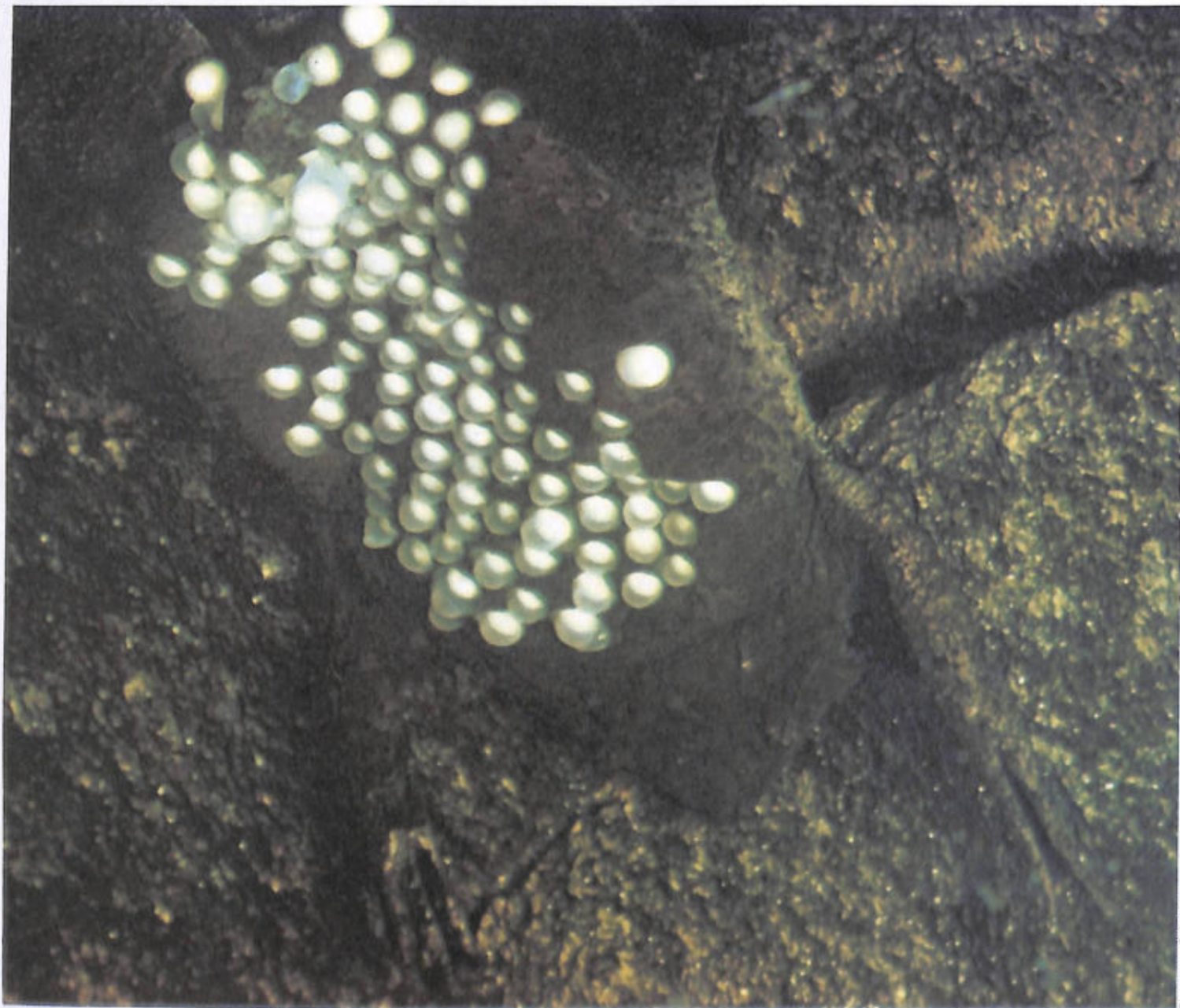
Madame Maria Sibylla Merian who went to Surinam or Dutch Guiana in 1699 to paint tropical butterflies found she had a vacant space at the end of her book so she included a fanciful picture, based on the local legend, of a mother opossum *Didelphis dorsigera* carrying her young ones on her back while they wrapped their tails around her tail for support. There was no scientific foundation for this picture but it has been copied in textbook after textbook until Dr Carl G Hartman exposed the truth of it in 1952 in his book *Possums*.

class **Amphibia**

order **Salientia**

family **Pipidae**

genus
& species ***Pipa pipa***



Constance P. Warner

Swallow

Swallows and martins make up one family whose members are all very alike. Indeed, the differences between swallows and martins are not easy to define and one species (p. 1574) is known as the sand martin in Britain and the bank swallow in the United States.

The bird known in Britain as 'the' swallow and in North America as the barn swallow has the widest distribution of all swallows. It is blue on the upper parts with a blue band around the chest, a red forehead and throat and white on the underside. The swallow is about 7½ in. in length and has a markedly forked tail. The North American form has pinkish or buff underparts. To many living in the northern hemisphere the appearance of swallows in spring is a welcome sight. A race of the Tahiti swallow, extending into Australia, has been named the welcome swallow.

Most swallows are wide-ranging, the common swallow breeds in Europe, Asia and North America, except for the extreme northern latitudes, and winters as far south as northern Australia, Sri Lanka, South Africa and northern Argentina. The red-rumped swallow has a more restricted range, in southern Europe and Asia and parts of Africa. Its near relative, the mosque swallow of Africa, is a reminder that most swallows live around buildings.

The cliff swallow and tree swallow range throughout North America and winter as far south as northern Argentina. Australia has its black and white swallow, and even more restricted is the golden swallow, with bronze-green plumage, of Jamaica and Hispaniola.



Sociable birds

Swallows spend much of their daytime on the wing, flying fast and skilfully, catching flying insects with their wide gaping mouths. They sometimes perch on twigs and reeds, and especially on telephone wires. They come to the ground almost entirely for collecting mud for building a nest, and then they shuffle awkwardly rather than walk, their feet and legs being small compared with the rest of the body. Their song is usually a twitter, although some species are slightly more musical than the common swallow, and this is especially heard when swallows fly in parties, as they often do when feeding. It is also heard when they are roosting in their hundreds in trees or in reed beds.

The saying that one swallow doesn't make a summer is an indication that the times of migration are less regular than in, for example, the swifts. Their progress north on the spring migration coincides closely

with the 48°F isotherm, which may give a spread of two weeks or more for the time of the swallows' arrival from one year to another. In addition there are individuals that arrive ahead of the main stream and there are those that stay after the rest have gone south again in autumn. The result is that in Britain and comparable latitudes swallows have been recorded in all months of the year except January.

Nests on rafters

There is a tendency for several pairs of swallows to nest fairly close together. Since their feeding space, the air, is abundantly supplied with food, a territorial instinct is of little use to swallows. The nest is typically a shallow cup made of pellets of mud reinforced with pieces of dry grass. It may, however, be more elaborate as in the retort-shaped mud nests of the cliff swallow. Originally the nests were built on cliff ledges or the branches of trees and when swallows





H Rehulich: Bavaria

nest in buildings they choose beams or brick ledges. The eggs, 3–7 in a clutch, are white, plain or speckled according to the species. They are incubated by the female for 2 weeks, and the babies stay in the nest for 3 weeks. Both parents feed the nestlings. There may be two, even three, broods a year except at the latitudinal limit of the breeding range. The juveniles from an early brood may help feed those of the next brood. When three clutches of eggs are laid in one season the last brood may be unfledged nestlings when the bulk of swallows are assembling for migration. The parents stay until the young leave the nest and they or the juveniles probably account for the swallows reported in November and December in northern temperate latitudes.

Victims of modernisation

In its breeding range in Europe the swallow is faced with a shortage of building materials, nest sites and food, due to modernisation. A nesting swallow needs mud to build the nest, some irregularity in a building upon which to site it and an abundance of small flying insects for food. At one time all highways had a margin of mud and it was a common sight on a spring morning to see swallows lining the sides of roads gathering mud for their nests. Modern highways do not offer this facility and the roadside swallows are seldom seen today. More recently has come the tendency to fill in ponds, another source of mud. The second need, the buildings, is less threatened, yet the fact remains that modern farm buildings offer fewer beams, rafters and other con-

◁ A parent common swallow takes a diagonal approach to feed three hungry nestlings. The female does most of the domestic chores. She builds the nest and although both sexes incubate, experiments with a thermocouple have shown that the male imparts little heat to the eggs. He lacks a functional brood pouch.

◁▽ A colony of cliff swallows on the underside of a rock face. This original site is less favoured than the eaves of barns and also railway stations, where the swallows take advantage of insects flushed by passing trains.

▽ Collecting mud for their elaborate nests is full time work for a group of cliff swallows.

venient nesting sites. Finally, the general greater cleanliness of stables and farmyards, combined with the use of insecticides has reduced the kinds of insects on which swallows feed.

Faithful swallows

Any deterioration, from the swallow's point of view, of the amenities of life, particularly in so far as it affects buildings, will create further difficulties because of the swallow's attachment to its nesting site. Swallows in spring set out from southern Africa on a long journey to Europe. Each comes back to the same place where it nested the year before. The fidelity to a particular spot in one particular building can be exemplified by the episode of the open door, which has been observed many times. Thus, last year a pair of swallows had their nest in a barn, stable or outhouse. To reach it they flew through an open window or door. Coming to the same place a year later they find the window or door shut. They do not immediately look for another site as most birds would but hang about in a perplexed manner waiting for the window or door to be opened.

class	Aves
order	Passeriformes
family	Hirundinidae
genera & species	<i>Cecropis daurica</i> red-rumped swallow <i>C. senegalensis</i> mosque swallow <i>Cheramoeca leucosternum</i> black and white swallow <i>Kalochelidon euchrysea</i> golden swallow <i>Hirundo rustica</i> common swallow <i>H. r. erythrogaster</i> North American barn swallow <i>H. tahitica</i> Tahitian swallow <i>H. t. neoxena</i> welcome swallow <i>Petrochelidon pyrrhonota</i> cliff swallow <i>Tachycineta bicolor</i> tree swallow



James Simon: Photo Ries



James Simon: Photo Ries

Swallowtail

Swallowtail butterflies get their name from the 'tails' on their hindwings which recall the forked tail of the swallow. They all belong to one family, the Papilionidae, but not all members of the family have 'tails'. There is, however, another feature which is more peculiar and is found in all members of the family. It is the possession by the larva of a protrusible Y-shaped organ, the osmeterium, situated just behind the head. It is usually orange or yellow and is normally hidden but can be suddenly pushed out if the larva is disturbed. It is connected with glands in the thorax of the caterpillar and when pushed out it disseminates a strong scent, which varies with the different species. This organ is also present in the larvae of the Apollo butterflies (p. 171) which although members of the Papilionidae are not usually regarded as swallowtails.

The 600 species of swallowtails are found everywhere except in the Arctic and Antarctic regions. Most are tropical: North America has 20–30 species, Europe

only five or six. Britain has one, *Papilio machaon*, which has a very wide range from western Europe through the whole of temperate Asia to Japan, and is represented by numerous races or subspecies. One of these, *Papilio machaon britannicus*, is the form native to Britain and is now confined to the Norfolk Broads.

Another species *Papilio podalirius* is called the 'scarce swallowtail' on the strength of a few specimens captured in southern England; it is common in France, Germany and other parts of Europe.

Papilio hospiton is remarkable in being entirely confined to Corsica and Sardinia.

Gathering at 'salt licks'

Swallowtails range widely in their choice of habitat; races of a single species may have markedly different habitats. The British race of the common swallowtail, for example, is strictly confined to marshes and fens; the French subspecies is an inhabitant of open country, especially chalk downs. In the tropical rain forest many swallowtails fly high in the treetops and some of the early collectors used to overcome the difficulty of catching them by shooting their specimens down with dust-shot. Another feature of

butterfly life in the rain forest, in which swallowtails feature prominently, is the habit of gathering in closely packed crowds on sand or gravel beside rivers and streams. If these butterflies are carefully watched they can be seen to be eagerly sucking up moisture with their long tongues. It is now known that most of these congregations gather where the urine of animals that come to drink at the water-side has soaked into the sand. Organic salts appear to be the attractant, and butterflies also gather at mineral springs and wet ashes. A curious feature of these congregations is that they consist entirely of males; the females feed only on the nectar of flowers and seldom come down to ground level.

Snake-like and poisonous caterpillars

Swallowtails have a typical butterfly life history. The larva feeds on the leaves of plants, the food plant of the common swallowtail being milk parsley and fennel in the wild; it can be reared on the leaves of carrot. One group of mainly tropical species confine themselves to the poisonous creepers of the genus *Aristolochia*. The poison taken in from this plant renders the caterpillars inedible to birds and as it persists in the pupa and the perfect insect, these also are protected against predators.



From caterpillar to butterfly, this series shows the spectacular transformation. First step, the larva spins a silk girdle and a button of silk at the tail to hold it in place



Firmly secured with its head facing upwards, the larva begins to shed its skin—note the wrinkled skin at the rear end—and a small part of the chrysalis is exposed.



Nearing completion, half a chrysalis and a crumpled mass of shed skin. This part of the transformation is short, taking only about 10–15 minutes. The long wait is to come.

Another curious form of protection in many swallowtail larvae is the eye-spots on the forepart of the body, which give the larva a snake-like appearance. In the tropics tree snakes are among the most deadly enemies of lizards and small birds, and merely to be reminded of a snake may well be enough to alarm them and so discourage attack. The scent of the osmeterium is undoubtedly defensive in function, and may be directed against parasitic wasps and flies.

The swallowtail pupae are attached by the tail to a leaf or twig. They face head upwards and are supported by a silk girdle.

Mimicry

Many swallowtails profit by looking like other more unpalatable species. The poisonous *Aristolochia*-feeding species, already mentioned, are protected from predation because they have a distinctive appearance, and birds quickly learn to recognise them as poisonous. In the course of evolution other swallowtails, acceptable as food for birds, have come to resemble the poisonous species and so gain protection by 'flying false colours'. One of the best-known mimetic species is the Oriental *Papilio memnon*. The male is a large blue-black butterfly with little tendency to vary, but the female appears in a number of varieties or

forms, some with 'tails' others without, each of which is a copy of one of the species of *Aristolochia* swallowtails. From the fanciful idea that he possesses many different wives, *P. memnon* is called the 'Great Mormon' by collectors in India and the Far East.

Another famous mimic is the African *P. dardanus*. Here again only the females are mimetic (the males are plain black and pale yellow), but they appear in a bewildering multiplicity of forms all of which mimic, not other swallowtails, but distasteful butterflies of various other families. In most parts of Africa a female *dardanus* will almost always prove to be a mimic of some poisonous species occurring in that particular locality. Only in Ethiopia and Madagascar is this butterfly non-mimetic; in these regions the females resemble the males.

Glorious butterflies

The swallowtails include some of the most brilliant and magnificent of all butterflies. Finest of them are the birdwing swallowtails of southeast Asia, New Guinea and tropical Australia. These butterflies are described on page 348. However, it can be recalled here that the female of one of these, *Troides alexandrae* from New Guinea, has a wing-span up to 10 in. and is the largest

butterfly known. *Drurya antimachus* of tropical western Africa is another enormous swallowtail, orange-brown with black markings and spanning 8 in. Here the male is considerably larger than the female, a condition contrary to that seen in the large birdwings. The species that swarm on contaminated sand in tropical Asia are mostly kite swallowtails of the genus *Graphium*, many of which are black barred or spotted with brilliant green or blue. The Bhutan glory *Armandia lidderdalei* of Assam and the royal swallowtail *Teinopalpus imperialis*, found in the same region, both have three tails on each hindwing, and both are sufficiently beautiful and remarkable to be known by English as well as Latin names. The small Asian *Leptocircus* have tails longer than the span of the forewings and their flight is as quick and strong as that of a hawk moth. No real idea of the splendour and diversity of swallowtails can be given unless a book is devoted to them.

phylum	Arthropoda
class	Insecta
order	Lepidoptera
family	Papilionidae



Herman Eisenbeiss

Chrysalid, or pupa, precariously suspended. The change to the adult butterfly within this angulate object takes from 10 days to 7 months depending on the time of year.



After 6½ months an adult European swallowtail *Papilio machaon* emerges but still clings to its chrysalid home for a few minutes while it straightens its wings out.



Photos by Herman Eisenbeiss

Complete metamorphosis, the swallowtail exposes its blue-banded wings to the daylight and gets ready to make its maiden flight; the empty chrysalid is still held by a silk girdle.

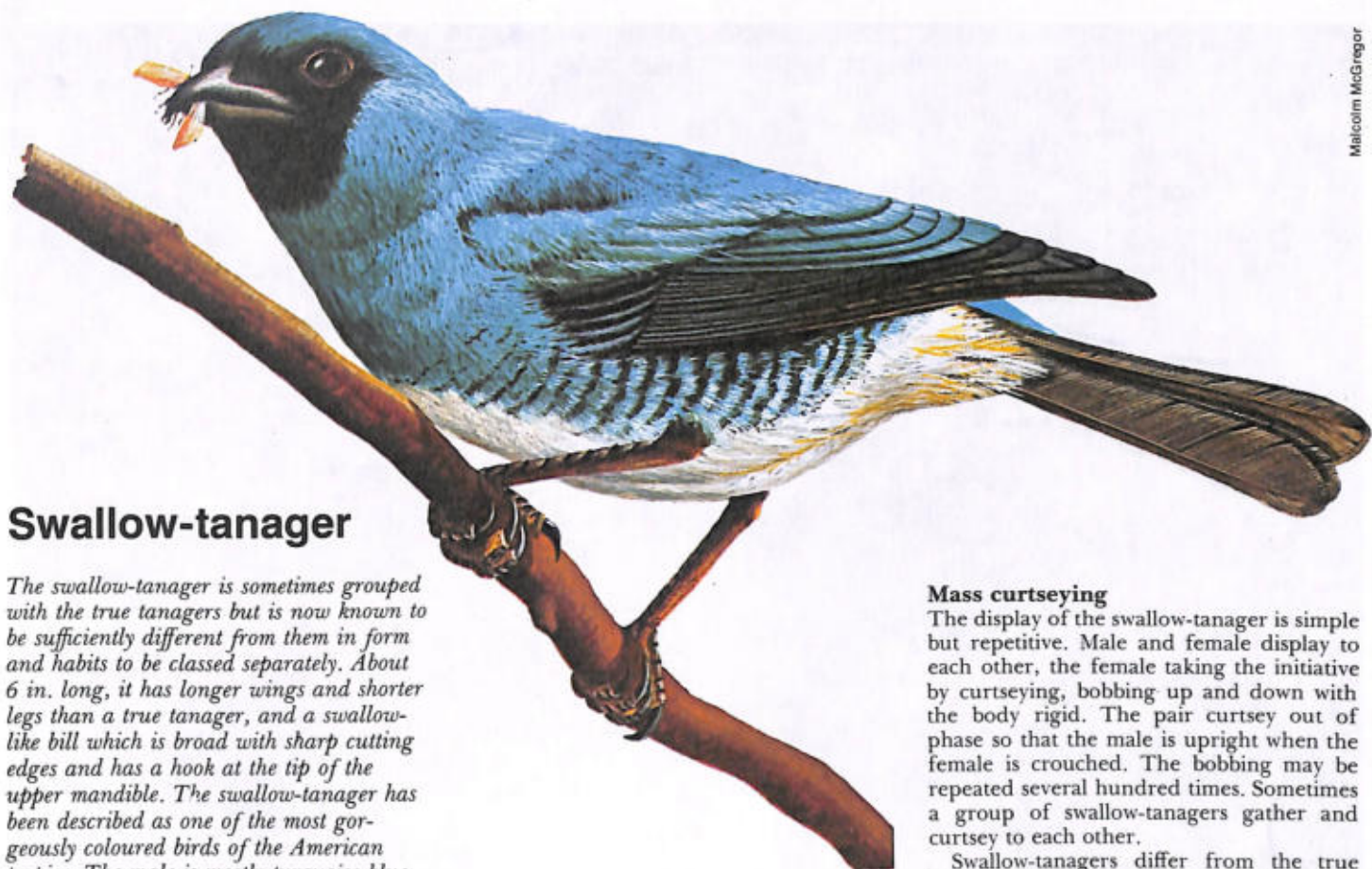


F. Baillie / NHPA

△ The beauty of this Japanese swallowtail *Papilio maackii* is indescribable, but it is easy to see how this butterfly got its common name.
▽ A peculiar habit of male swallowtails is to gather at places where an animal has urinated beside a river or stream and to suck up the moisture-containing organic salts from the sand. In this such gathering are three species of kite swallowtails. The females feed on the nectar of flowers.



M. Tweedie



Swallow-tanager

The swallow-tanager is sometimes grouped with the true tanagers but is now known to be sufficiently different from them in form and habits to be classed separately. About 6 in. long, it has longer wings and shorter legs than a true tanager, and a swallow-like bill which is broad with sharp cutting edges and has a hook at the tip of the upper mandible. The swallow-tanager has been described as one of the most gorgeously coloured birds of the American tropics. The male is mostly turquoise blue when seen against the light but this changes to emerald green when seen with the light. The face and throat are black with black bars on the flanks and white in the centre of the belly. The female is very different; she is bright green with yellowish underparts and a grey throat.

Swallow-tanagers live in Central and South America, from Panama to Bolivia and Brazil, including Trinidad.

Partial migration

Outside the breeding season swallow-tanagers live in flocks, keeping to themselves. At that time of the year they are found in the humid lowlands, but at the start of the breeding season they move into mountainous and hilly regions, particularly where there is evergreen forest festooned with dense growths of creepers. The lower limit of their breeding range is at the level of the deciduous woodland. Swallow-tanagers are not as vocal as many other tropical birds. Their songs are very weak and are not heard until late in the morning.

Soft food preferred

Swallow-tanagers feed on both fruit and insects. Fruit forms the bulk of their food in the dry season, but they turn to insects at the start of the rainy season when swarms of flying insects appear. These are caught flycatcher fashion, by flying out from a perch as an insect passes. Most of the insects caught are flies but small locusts, butterflies and flying ants are also eaten. There is a decided preference for soft-bodied insects. This is not surprising as swallow-tanagers also prefer soft, pulpy fruit such as avocados.

△ The male swallow-tanager has a rich turquoise plumage which flashes to emerald in the sun as the bird flies out after insects.



△ Unadorned and unlovely: 3 six-day-old chicks.
▽ Granite bank with one occupied nesting hole.



Mass courtseying

The display of the swallow-tanager is simple but repetitive. Male and female display to each other, the female taking the initiative by curtseying, bobbing up and down with the body rigid. The pair curtsey out of phase so that the male is upright when the female is crouched. The bobbing may be repeated several hundred times. Sometimes a group of swallow-tanagers gather and curtsey to each other.

Swallow-tanagers differ from the true tanagers by nesting in holes rather than building cup-shaped nests in the open. Crevices in buildings and the abandoned burrows of jacamars or puffbirds may be used, or the swallow-tanagers may excavate their own burrows in a bank, which vary from as little as 6 in. to as much as 6 ft deep. The nest of grass and flowers is built at the end of the burrow by the female, who also digs the hole. The 3 white eggs hatch in 13–17 days. The male helps to feed the chicks which stay in the nest for 24 days.

Gluttons for fruit

The name swallow-tanager could almost be a slang term describing the feeding habits of these birds. Ernst Schaefer, who has studied swallow-tanagers in the wild and in captivity, has described the way the large, sharp-edged bill is used to scrape the fleshy pulp from fruits and then eject the stone instead of swallowing it as many other fruit-eating birds do. The mouth is opened very wide and the fruit, which may be larger than the bird's head, is engulfed like a snake working its way over its prey. The fruit is then twisted around in the mouth until all the flesh is scraped off. Schaefer's tame swallow-tanagers ate two-thirds of their own weight in fruit each day. They do not have a crop but store the pulp in a greatly elastic throat which bulges out into strange shapes.

class	Aves
order	Passeriformes
family	Emberizidae
genus & species	<i>Tersina viridis</i>



Swamp eel

Apart from their eel-shape, swamp eels are in no way related to true eels. They mainly breathe air and have more or less lost their gills. In fact it is hard to say what these unusual fishes are related to.

Some of the peculiarities of swamp eels are that they usually have no paired fins, the dorsal and anal fins are without fin-rays—they are little more than soft ridges which meet at the hind end of the body—and there is usually a single gill-opening on the throat. The lateral line is well-marked. The scales are very small, the eyes are small and covered with skin or else are absent altogether. The colour is black, brown or green, often with spots or streaks of yellow, red or brown. Swamp eels are 1–5 ft long.

There are about eight species in the freshwater and brackish swamps of Central and South America, tropical West Africa, Asia and Australia. One species, *Anommatophasma candidum*, was discovered a few years ago living in underground waters in northwest Australia. The *cuchia* of India is placed in a separate family, the *Amphipnoidae*. There is one marine species, *Macrotrema caligans*, off the coasts of Malaya.

Amphibious fishes

Swamp eels mainly live in waters poor in oxygen which are liable to dry out. They avoid the light, and so tend to move about mainly at night. They do not use gills for breathing as much as other fishes. The main way of breathing is to come to the surface to gulp air, or they may even wriggle out over the surface of the swampy mud. Some swamp eels are as amphibious as many frogs and toads. In summer they burrow into the mud and go into a kind of summer sleep or aestivation.

The accessory breathing organs are different for almost each species. The *cuchia* of India and Burma has very small gills but it has a large lung-like sac opening from each gill cavity which extends up to behind the head and a short way along the back. These are only just under the skin and when inflated the skin behind the head bulges. Another species, the rice eel, from China and Japan to Burma, Thailand and the Malay Archipelago, uses the throat and the hind portion of its intestine for breathing. The lining membranes of these are richly supplied with blood vessels and act as lungs. More extraordinary are the species of *Synbranchus* which seem to use their gills for breathing air. They come to the surface to gulp air, the oxygen from the air passing directly, so far as we know, into the blood in the gills. Certainly when aestivating, the fish must be able to use the gills in this way.

Breathing involves not only an intake of oxygen but also the removal of carbon dioxide from the body. There are indications that in swamp eels much of the disposal of carbon dioxide is through the skin.

Fishes without eyes

The *cuchia* buries itself as deep as 2–3 ft in soft mud in summer, and since most fishes have no eyelids there must be some adaptation to meet this. The eyes are sunken and are covered with a thick semi-transparent skin formed of several layers of epidermal cells and a layer of connective tissue. This covering is flush with the surface of the body, so it offers no impediment to burrowing. The eye itself is degenerate. The lens is spherical and its inner surface is practically touching the retina, which consists almost entirely of cones set well apart. The structure of the eye shows it is of little use for vision, and this is confirmed by the fact that there are few blood vessels supplying the eye. Because so little oxygen reaches the eye, vision is bound to be poor. Even those swamp eels with eyes supplied with blood vessels probably use them no more than to tell light from darkness. *Tylosynbranchus* is totally blind.

Hearty appetites

If the gills, eyes and fins of swamp eels are degenerate, the mouth makes up for this by being strongly developed. It is relatively large with thick lips, and there are rows of

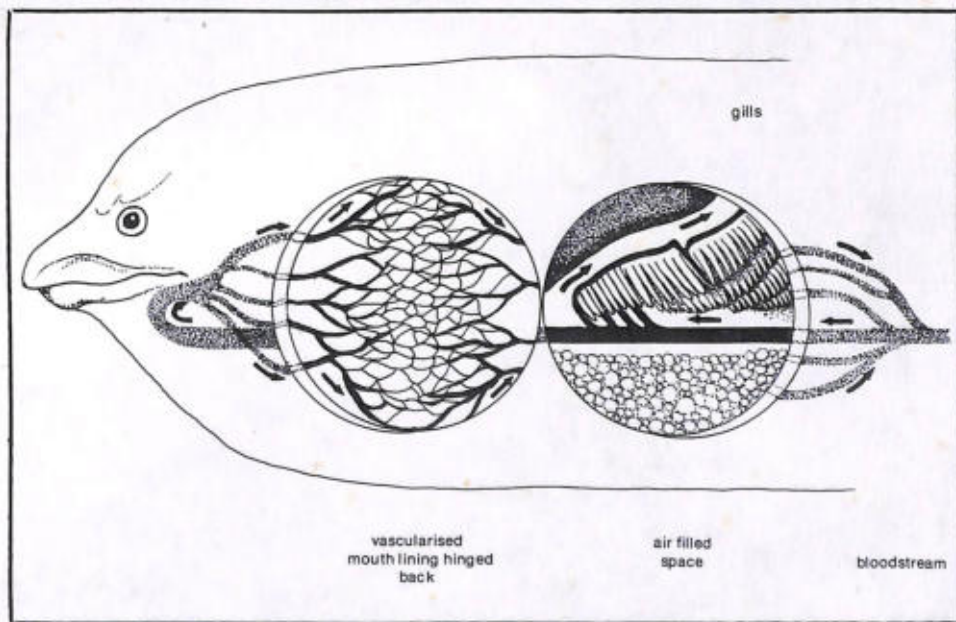
the eggs and of the young when they hatch. It is usually said that he guards them, but a more likely role is that of supplying them with oxygen through his skin. When the young fishes first hatch they have large pectoral fins well supplied with blood vessels that are used for breathing. These drop off when the young fishes are 10 days old.

Stagnant protection

Swamp eels are largely protected from aquatic predators by living in stagnant waters but they are the prey of large swamp-feeding birds such as storks and herons. In some places they are used as food by the local people. This is especially true of the rice eel, which has also been successfully introduced into Hawaii.

Cart before the horse

Almost any elongate fish is liable to be called an eel, so we have conger eels, moray eels, slime eels, spiny eels, cusk eels, rock eels, and swamp eels. The usual remark made is that these fishes tend to look alike because they all live under the same conditions. In other words, the resemblance between them is due to the often-mentioned convergent



△ *Respiration system of Synbranchus, with flap of mouth lining hinged back to show gills. The fish gulps air at the surface, which passes direct into the bloodstream via the vein network and gills.*

◁ *A rice eel sinks back after rising for air, which will be absorbed in the throat and intestine.*

teeth on the jaws and the palate. Swamp eels feed on worms, snails and other small invertebrates, or on fishes. They are said by aquarists to be snappy, rapacious and greedy, eating their own weight of food a day—when they are not aestivating.

Bubble-nesting male/female

One species, the rice eel, has been found within the last few years to be first male, later changing to female. The first sign that this species is about to spawn is when the male builds a nest of bubbles. He gulps air at the surface and spits out the mucus-covered bubbles at the surface, where they form a raft. As the female lays, the male takes each egg in his mouth and spits it onto the underside of the raft. When the clutch is complete he takes over the care of

evolution. We have to remember, however, that so much of biology belongs to the hen and egg realm: which came first, the hen or the egg? It may equally well be that in many instances the fishes became eel-shaped and this made it possible for them to survive in similar environments. This is probably especially true of swamp eels.

class	Osteichthyes
order	Synbranchiformes
families	Synbranchidae, Amphipnoidae
genera	<i>Amphipnous cuchia cuchia</i>
& species	<i>Monopterus albus rice eel</i> <i>others</i>

Swan

The six species of swan are very closely related to the geese. Together they make up a tribe of the order Anseriformes separate from the various tribes of ducks. One possible exception is the Coscoroba swan of South America, which is the smallest swan and has a comparatively short neck; it is thought to be in some way related to the whistling or tree ducks.

The most familiar swan is the mute swan that originally bred in parts of Europe and Asia, but has been domesticated and introduced to many parts of the world such as North America and Australia where it has gone wild. It is thought that it was introduced to Britain by the Romans. The mute swan is 5 ft long and

weighs about 35 lb. The plumage is all white and the bill is orange with a prominent black knob at the base. The Bewick's swan and the whooper swan are two other species that breed in Eurasia. Bewick's swan breeds in the tundra of northern Russia and Siberia and visits Europe in the winter. The whooper swan breeds farther south, including northern Scandinavia and Iceland, with a few pairs nesting sporadically in Scotland. Both have black bills with a yellow base, the pattern differing slightly between the two, and Bewick's swan is rather smaller than the whooper with a shorter neck. There are two swans in North America; the whistling swan has a black bill, sometimes with a yellow spot at the base, and is smaller than the trumpeter with a completely black bill. The whistling swan breeds mainly north

of the Arctic Circle and migrates to the southern coast of the United States. The trumpeter used to breed over much of North America but is now confined to the northwest United States and southwest Canada where there are now about 1 500 individuals under protection. The only swans in the southern hemisphere, apart from the Coscoroba swan, are the black swan of Australia, and the black-necked swan of South America, from Brazil to Tierra del Fuego and the Falkland Islands. The black swan is all black but with white primary wing feathers, and a red bill. It has been introduced to New Zealand. The black-necked swan has a black head and neck, a white eyestripe and a red bill.

▽ Mute swan takeoff. Their heavy bodies clear the water of the pond with difficulty.







Not so mute

Compared with other swans the mute swan is quiet, but its name is a misnomer for it has a variety of calls. A flock of mute swans can be heard quietly grunting to each other as they swim along a river. When disturbed or in defence of the nest mute swans hiss violently. The sighing noise during flight is caused by the wings. The whooper swan has a bugle-like call when flying and a variety of quiet calls when grounded. Bewick's swan has a pleasant variety of honks and other sounds and the trumpeter is named after the trombone-like calls produced in the long, coiled windpipe. It is said that the swan-song, the legendary song of a dying swan, is based on a final slow expiration producing a wailing noise as it passes through the long windpipe.

A danger to cables

Despite their great weight swans are strong fliers. They have four times the wing loading (the body weight divided by the surface area of the wings) of a herring gull or crow and they have to beat their wings rapidly



◁ Snow white beauty of an arrogant mute swan.

1 Profile: head of a whooper swan.

2 Swan song? A black swan stretches up its neck and wails through its long windpipe.

3 Reflecting swan: the Coscoroba swan has features of both ducks and swans.

4 Black-necked swans guard their young.

5 A pair of Bewick's swans sit upright on the water while their young paddle around.



to remain airborne. A high wing loading makes take-off and landing difficult and swans require a long stretch of water over which they can run to gain flying speed or surge to a halt when landing. Swans are also unable to manoeuvre in flight and the chief cause of mortality in built-up parts of the world is collision with overhead cables.

Shallow water feeders

Swans feed mainly on plants but they also feed on water animals such as small fish, tadpoles, insects and molluscs. They often feed on land, grazing on grass like geese, but more often they feed on water plants, which they may collect from the bottom by lowering their long necks underwater, sometimes upending like ducks. This limits the swans' distribution to shallow water because they very rarely dive and are only occasionally seen on deep water.

Centuries-old colonies

Swans nest near water. Male mute swans set up territories, each defending a stretch of river from which they drive other males and young swans. Intruders are threatened





Chicago



Toni Angermayer

- △△ Courting swan. In the Greek legend Zeus disguised himself as a swan in order to seduce Leda.
 △ Feather maintenance. A mute swan preens its feathers, cleaning and oiling them with its bill.
 ▷ A pair of nesting mute swans, seen through the reeds, renovate their nest.



by an aggressive display in which the neck is drawn back, the wings arched over the back and the swan propels itself in jerks with the webbed feet thrusting powerfully in unison, instead of alternately as in normal walking. There are a variety of displays between the male, the cob, and the female, the pen, involving tossing and swinging the head and dipping it into the water.

Mute swans mate for life and nest in the same territory each year, some violent fights taking place if a new pair tries to usurp the territory. The nest is a mass of water plants and twigs, roughly circular and cone-shaped with a depression in the centre. Wild mute swans nest among reeds on small islands in pools but semi-domesticated ones may nest in the banks of ponds in parks or in other inhabited places. Occasionally, mute swans nest in colonies rather than spaced out territories, such as the large colony at Abbotsbury in southern England.

There are usually 5–7 eggs, sometimes twice as many, and they are incubated mainly by the female, the male taking over only when she leaves to feed. In the smaller swans incubation lasts 4 weeks, but it is 5 weeks in the larger species and 5½ weeks in the black swan. While the last eggs are being brooded by the female the male takes the cygnets to the water. The family stays together until the cygnets fledge at 4–5 months. When young they swim together in a tight bunch with the female leading and rooting up plants for them to eat.

Swan-upping

By the 13th century the mute swan no longer existed as a wild bird in England. All swans were the property of the Crown or certain individuals and bodies who owned swans under royal licence. The sovereign had a swan-master who enforced the practices of swan keeping. Individual swans were marked on the bill or feet with a series of notches or more elaborate marks to indicate ownership. This practice still survives on the Thames where cygnets are marked annually in a practice known as 'swan-upping' and the Abbotsbury swans are still marked on the webs of the feet. Otherwise, mute swans have reverted to their wild existence.

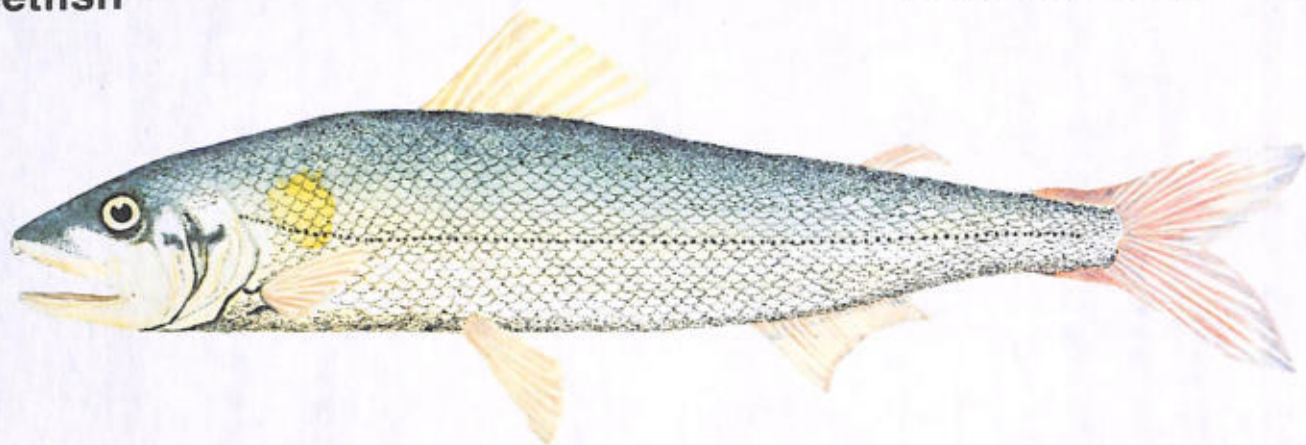
The value of the swan to the Crown and others was as food and as a status symbol. Swans were served at banquets, with their feathers replaced after cooking and some were artificially reared for the table.

class	Aves
order	Anseriformes
family	Anatidae
genera	<i>Coscoroba coscoroba</i>
& species	<i>Coscoroba swan</i> <i>Cygnus atratus</i> black swan <i>C. columbianus bewickii</i> <i>Bewick's swan</i> <i>C. c. columbianus</i> whistling swan <i>C. cygnus buccinator</i> <i>trumpeter swan</i> <i>C. c. cygnus</i> whooper swan <i>C. melanocoryphus</i> <i>black-necked swan</i> <i>C. olor</i> mute swan



Sweetfish

The delicious sweetfish *Plecoglossus altivelis*.



Chris Howell-Jones

The sweetfish or sweetmouth is known to the Japanese as ayu, except when it is living in land-locked waters when it is called koayu. It is famous as the fish caught with cormorants. While the cormorants and the cormorant fishers are so well known in pictures, carvings, and in prose, the fish itself rarely has a mention, and then only a brief one. Yet the sweetfish has been described as 'fabulous' meaning that it is remarkable almost beyond belief. Its flesh is said to be delicious; and it is one of the important commercial fishes in Japan. The reason

why so little is known about the fish is that although many studies have been made of it, the results of these have, with rare exceptions, been printed in Japanese.

The fish, up to a foot long, has much the same shape as a salmon, with prominent jaws extending well back behind the moderately large eyes, as in the salmon, and there is an adipose fin near the tail end of the body, with a fair-sized dorsal fin about the middle of the back. The sweetfish was at one time classified in the salmon family but is now placed in a separate family of its own.

Ceremonial fishing

Cormorant fishing in China and Japan dates from at least the 12th century. It was practised in other countries, such as in England, where different fish were caught.

In Japan in the 12th century, fish caught in the Nagano river were sent to the Emperor Yoritomo. In 1890 parts of the Nagano river were set aside for the Emperor and the fishing was continued there as an imperial ceremony. The principle is to slip a ring over the neck of a cormorant and put it into the water, with a cord tied to the ring. The bird catches a fish but cannot swallow it. It is drawn into the boat, and its neck gently squeezed so the fish is

An 1830's print of Chinese fishing with cormorants. The rings around the cormorants' necks prevent them from swallowing the fishes that they catch.



Mary Evans Picture Library

ejected; the cormorant is then sent out to catch more fish. At the end of the fishing the bird is rewarded with some of the less valuable fish it has brought back.

Combing food from rocks

Most of these fish are caught in the rivers and in land-locked stretches of water, and some are artificially fed in ponds. The first teeth of the very young fish are conical, which helps them catch and eat plankton, such as waterfleas and copepods. When the young fish is about 1½ in. long, it grows a second set of teeth, on the outer edges of the jaws. These have comb-like edges and are used for nibbling small algae on rocks. The fish feed mainly in the mornings and again in the evenings, and a single fish will consume 30–50% of its own weight of algae in a day, the food being digested in 2½–5 hours. When artificially fed, on rice bran, potato and wheat, they feed throughout the day but take only 15–25% of their body weight of this more nourishing and satisfying food.

Weight-lifting spawners

Sweetfish are marine but come up the rivers to spawn in early summer, the season lasting into early autumn. The males are slightly bigger in the body than the females and have somewhat larger pectoral, dorsal and anal fins. At the beginning of the spawning period the males outnumber the females, but by the end of the period the females predominate. The newly arrived

males crowd together and their movements agitate the water at the bottom, which clears the pebbles of silt. The females choose their spawning places by the sizes of the pebbles the males have exposed. The smaller females station themselves where the pebbles are ½ in. or less across, the larger females choosing places where the pebbles are ¼–1 in. diameter. This discrimination is made because they move some of the pebbles to make shallow circular pits to lay their eggs in, so the smaller females have to shift only small pebbles. The eggs fall among the pebbles and stick to their surfaces. The larvae that hatch from them still have the remains of the yolk sac so they drift upside down at the surface and are carried along by the current. In only a few hours the yolk sac is used up, the jaws grow and by the time they reach the estuaries and the coastal waters, the young fish are able to feed.

Making fish jump

An interesting observation was made by K Koidsumi a few years ago when transferring *ayu* fry to an experimental pond. At one end an inlet of cascading water entered the pond and for 3 days the fry tried to leap up this artificial waterfall, as salmon try to leap a weir. Then the impulse seemed to die down and the fry lived quietly in the pond. If we take the results of a number of studies we can see three sets of conditions that make fish leap out of water. Some fish will leap to get over a torrent or

a waterfall. Others will leap in what appears to be play; for example, garfish have been seen to leap out of the sea somersaulting over a floating log or a turtle. More commonly it is the result of sexual excitement. Then there is the third set of circumstances: the leaping for food, or to escape from a predator, or to leap out of water when conditions are unsuitable or for any reasons that make the fish uncomfortable. The fry placed in the pond were doubtless ill at ease on finding themselves in strange waters, and it is interesting that they should have made their way to a 'waterfall' to do their leaping.

An example of fish that do not normally leap, jumping out of the water through discomfort, can sometimes be seen in lakes where a main road runs near the water's edge. Every time a heavily laden lorry rumbles by, fish will leap out, and it is always at the same spot, presumably where the vibrations are most felt. People who live near a lake have reported seeing fish leap out of the water up to 100 yd away every time a door on the outside of the house is slammed.

class	Osteichthyes
order	Salmoniformes
family	Plecoglossidae
genus & species	<i>Plecoglossus altivelis</i>

Japanese fishing with cormorants by torchlight. This ingenious method of catching fishes, including sweetfish, dates from the 12th century.



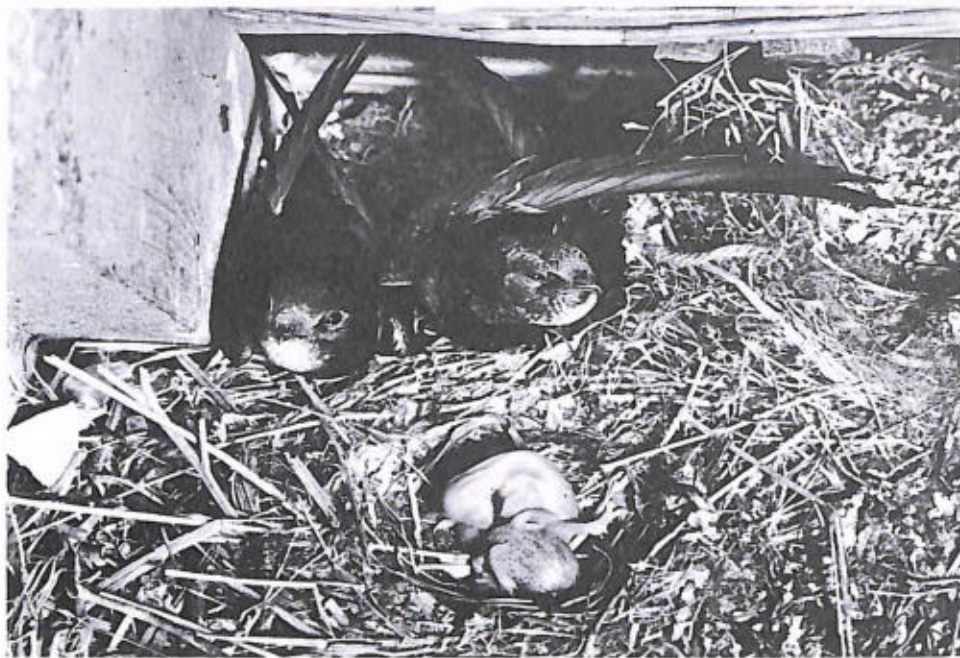
Swift

Perhaps no other birds are so well adapted for an aerial life as the swifts. They feed, mate, bathe, collect nest material and sometimes sleep in the air. Their wings are long and narrow for rapid flight and their legs very weak, but the idea that swifts cannot take off from the ground is not true. Under normal circumstances only a sick or injured swift will land on the ground, and then it is unlikely to be able to take off. The body is designed for high-speed flight but not for manoeuvring. The wings are like those of the related hummingbirds: the arm bones, the humerus and ulna, are short and the hand bones are long, the primary, instead of the secondary, flight feathers taking up most of the wing.

There are two families, the crested swifts and the true swifts. Included in the true swift family are the spintails (p. 2350) and the swiftlets (p. 2458). All swifts are very similar in appearance due to them all having dark plumage. The European representative of the true swifts is the common swift, known in Britain simply as the swift. It is 6 in. long and weighs 1½ oz but has a wingspan of 16 in. It breeds in most of Europe, Central Asia and North Africa. The common swift has a black plumage with a whitish chin and a short forked tail. These characters enable it to be distinguished from near relatives such as the white-rumped swifts of Africa and Asia with almost square tails and white rumps. The pallid swift is a paler brown with more white on the throat. It breeds around the Mediterranean coast of Europe, North Africa and Asia Minor. The alpine swift is much larger than the common swift with brown plumage, white throat and underparts separated by a brown band. It breeds in southern Europe, North Africa, southern Asia, and southern and eastern Africa including Madagascar. Another Old World swift is the palm swift of Africa and Asia, not to be confused with the palm swift of tropical America. Also in America there are the scissor-tailed swifts with deeply forked tails and the white-throated swifts of western United States.

Maestro flyers

Most swifts live in tropical regions where the flying insects that form their food are abundant all the year round. Those that live in temperate regions have to migrate to warmer regions for the winter, the common swift flying to South Africa. The common swift spends only 3–4 months of each year in Britain and even then it runs the danger of a food shortage due to bad weather. Swifts avoid starvation during short spells of bad weather in two ways. They may roost together in a torpid, almost cold-blooded state, so conserving energy, or they may fly away from bad weather. They have the speed not only to fly around showers and



John Marikham

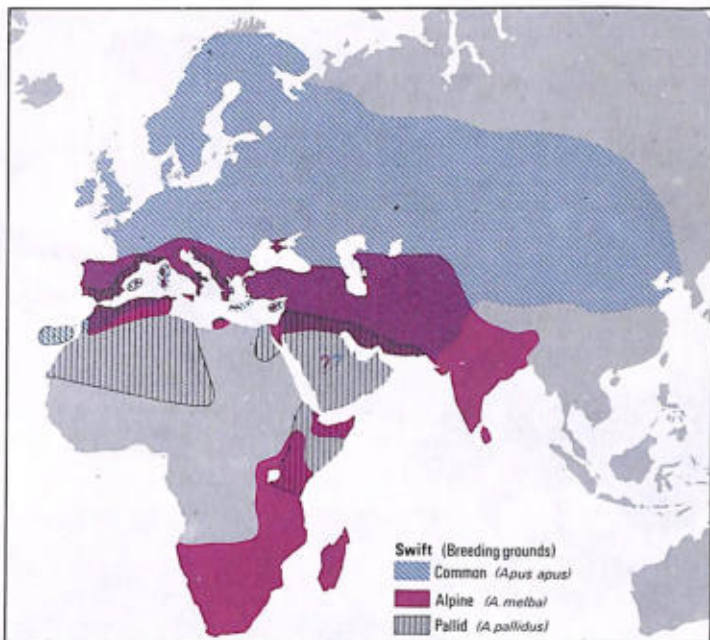


John Marikham

◁ A pair of common swifts, their throats bulging with food, return to their nest in a thatched roof, to feed their young.

◁ ▽ A common swift takes a momentary break. They are rarely seen on the ground as they spend almost all their time on the wing. When they do land, they usually cling to vertical surfaces.

▽ Palm leaf nest site poses problems. An adult and two juvenile Old World palm swifts. The eggs are glued to the nest with saliva and the parent birds have to brood in a vertical position.



local thunderstorms but can also fly in flocks for several hundred miles around depressions so avoiding belts of rain. To be able to perform these feats swifts have to fly fast and with little effort. In World War I, however, the pilot of an aeroplane calculated that swifts flying near him were travelling at 68 mph.

Plankton of the skies

Swifts feed on the aerial plankton, the myriads of small insects and other animals that float through the air in the same way that the more familiar plankton floats in the sea. Similarly, the animals in the aerial plankton are too small to see with the naked eye but can be caught by trailing fine mesh nets. A large proportion of these insects, which are scooped up in the swifts' widely gaping mouths, is small flies and aphids, but they also eat spiders which have been swept aloft on their gossamer, small moths and honeybee drones. Apparently swifts are able to distinguish the harmless drones from the stinging worker bees. Not surprisingly, swifts are most often seen where the aerial plankton is abundant. On warm days they can be seen flying high up and on windy days they patrol lines of trees where the insects have been caught in the eddying wind. Rubbish dumps with their attendant swarms of flies are popular feeding sites and swifts also hunt over ponds for the aquatic insects flying low over the surface.

They drink by dipping down to water while in flight and swifts also bathe in the same manner, by plunging into the water and fluttering clear again.

Nests stuck with lick

Common swifts originally nested in holes in cliffs but nowadays they nearly always nest in buildings, using gaps in stone-work, under eaves or among rafters. The nest is made of feathers, leaves, straw, petals, paper, or anything small and light enough for the swift to have found floating in the breeze. Both members of the pair collect material and work it into the nest, using saliva to cement it into place, as do other swifts.

The nest of the common swift is nothing outstanding but some of its relatives have quite astonishing nests. The Old World palm swift simply glues its eggs to a shallow bowl of feathers attached to a vertical palm frond with saliva and incubates by perching over them. The American palm swift also hangs its eggs on a palm frond but builds a more elaborate nest. It is a bag of feathers and fibres, cemented together with saliva, and with an entrance at the bottom. The eggs lie in a cup at the bottom of the nest. Even more elaborate is the nest of the scissor-tailed swift, which is a sleeve of fibres and feathers up to 2 ft long, hanging from an overhanging rock or branch. The swift enters by climbing up the sleeve to the eggs on a ledge at the top.

The common swift mates on the nest or in the air. The act is difficult to observe as there are few preliminaries and it takes place in a few seconds. The 2-3 eggs are laid at 2-3 day intervals and are incubated by both parents in turn for 19-20 days. The newly-hatched chicks are naked and blind. Brooding takes a week. They grow rapidly if food is plentiful and exercise their wings doing 'press-ups'—pushing down with the wings to raise the body off the ground. The chicks leave the nest when 5-8 weeks old. The wide variation is due to the fluctuations of available food. If food is short the chicks become torpid to conserve energy and survive long periods of starvation.

Sleeping aloft

Swifts have several amazing attributes, including their avoidance of bad weather by flight or torpidity, their strange nests cemented with saliva, and the ability to perform so many activities in the air. Of the last, one of the most incredible is the habit of spending the night on the wing. At dusk the nesting swifts return to their holes while the non-breeders can be seen circling higher and higher until they disappear from sight. In the morning the flock can sometimes be seen descending. It can only be guessed that these swifts are roosting in flight, but there is confirmation from radar observations and from aeroplanes that these flocks of swifts spend the night aloft several thousands of feet up. Presumably they take short 'cat-naps' as they glide between bouts of flapping.

class	Aves
order	Apodiformes
family	Apodidae
genera	<i>Aeronautes saxatilis</i>
& species	<i>white-throated swift</i>
	<i>Apus affinis</i> <i>white-rumped swift</i>
	<i>A. apus</i> <i>common swift</i>
	<i>A. caffer</i> <i>African white-rumped swift</i>
	<i>A. melba</i> <i>alpine swift</i>
	<i>A. pacificus</i> <i>Asian white-rumped swift</i>
	<i>A. pallidus</i> <i>pallid swift</i>
	<i>Cypsiurus parvus</i>
	<i>Old World palm swift</i>
	<i>Panyptila sancti-hieronymi</i>
	<i>scissor-tailed swift</i>
	<i>Tachornis squamata</i>
	<i>New World palm swift</i>

Swiftlet

Swiftlets can cling to vertical rock faces, for like the spintailed swifts (p. 2350) they have spiny tips to their tailfeathers. They are especially worthy of note for two reasons. Their nests are collected for 'birds' nest soup' and they can navigate by echolocation like the oilbird (p. 1749). In appearance the swiftlets are very much like other swifts, having the same small bills, long narrow wings and slightly forked tails. Very few other groups present such a difficult task of classification as the swiftlets for they are so similar in appearance, yet there are minor distinctions that prevent them being lumped together. They are $3\frac{1}{2}$ – $6\frac{1}{2}$ in. from bill tip to the end of the tail and their plumage is mainly dark grey or brown with whitish underparts and rumps. Some swiftlets have metallic greens and blues in their plumage.

The 20 or so species of swiftlets are found in southeast Asia from India to the Philippines and on islands in the Indian and Pacific Oceans.

Cave nesting

Swiftlets are excellent fliers and feed on small floating or flying insects. Many swiftlets nest in caves, often in large numbers. At the Niah Cave in Sarawak, for instance, the 2 million pairs of black-nest swiftlets make an impressive sight as they wheel in masses over the cave entrance before going in to roost. Others are known to nest in potholes, sometimes 200 ft below ground level. In the Andaman Islands there is a swiftlet which lives in sea caves where the entrances are covered by each wave. The swiftlets have to dodge in and out as each wave recedes. Other swiftlets such as the glossy or white-bellied swiftlet nest in hollow trees or on buildings.

Like other swifts, swiftlets use their cement-like saliva for making their nests. The nests are cups fixed vertically onto walls, and more saliva may be used in their construction than in those of other swifts. The nests of some species are made wholly of saliva which is at first translucent and pliable but later sets hard. Other swiftlets add material such as pieces of plants and fungi and the black-nest swiftlet plucks feathers from its own plumage to incorporate into the nest.

Birds' nesting with a difference

For hundreds of years the nests of swiftlets have been relished by the inhabitants of southeast Asia and the collecting of the nests for 'birds' nest soup' has been a lucrative occupation. Apart from the taste, the nests were supposed to have aphrodisiac properties, but it has been shown that there is little nourishment in them.

The nests are collected twice a year by men who climb up precarious poles, sometimes to incredible heights, in high caves to knock the nests down. The nests of almost pure saliva, as made by the white-nest swiftlets, fetch the highest prices as others have to be processed to remove the other



Nesting activities among a colony of glossy swiftlets. Swiftlets are best known as the birds whose nests are collected in the Far East to make 'birds' nest soup'. Swiftlets have well-developed salivary glands—saliva being used in nest building. *Collocalia* species go to the extreme: nests are made almost wholly of saliva.



nest material. The hardened saliva is served in soups or mixed with spices and sauces.

In recent years the standard of living throughout the swiftlets' range has risen and the prices paid for nests has fallen. As a result fewer men are willing to take risks to obtain the nests and the industry is falling into decay, so that licensing schemes needed in the past are becoming obsolete.

Drawbacks of cave life

The breeding seasons for many swiftlets are not well known. Many probably nest all the year round. The glossy swiftlet has three breeding seasons a year. There are two white eggs in each clutch which are incubated for 3–4 weeks depending on the species. Both adults incubate and feed the chicks, which are blind and naked at hatching and are brooded at first. The adult plumage develops directly without a preliminary coat of down. The chicks fly after 5–8 weeks in the nest. Although the cave can be considered as a relatively safe environment, swiftlets are subject to some predation.

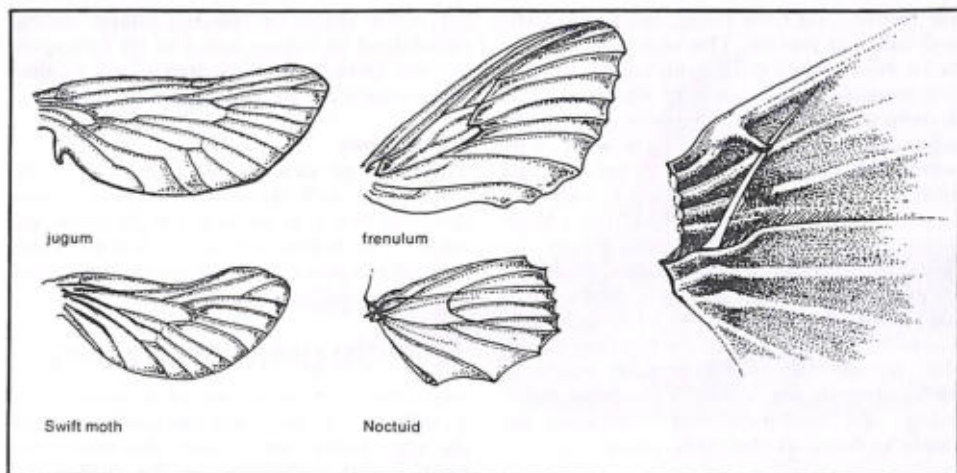
Some chicks are lost by falling out of the nest and birds of prey wait outside the caves for unwary birds, but swiftlets also face some unusual hazards; the eggs may be attacked by a cave cricket and the nests eaten by a moth of the family Pyralidae.

Free to click

When swiftlets fly into their pitch-dark caves to roost or visit their nests they can be heard giving a series of penetrating clicks that sounds like an irregular rattle. The sounds are impulses that are used for echolocation. The navigational system of the swiftlets is probably used only for detecting obstacles and following the walls of their caves, although it must be sensitive enough for them to locate their nests accurately.

Not all swiftlets have the power of echolocation. The glossy swiftlet that lives at the entrances of caves lacks this ability. This species carries its nest material in its bill, as do other swifts, but those swiftlets that use echolocation to reach their nests, carry nest material in their feet, so leaving the mouth free for producing the clicks.

class	Aves
order	Apodiformes
family	Apodidae
genus & species	<i>Collocalia esculenta</i> glossy swiftlet <i>C. maxima</i> black-nest swiftlet <i>C. vestita</i> white-nest swiftlet others



Chris Howell-Jones



George Hyde

△ Differences in wings and wing coupling devices in a swift moth and a more advanced noctuid moth. Swift moths have similar venation on both the fore- and hindwings—a primitive feature found in fossil moths. The coupling is also primitive, the jugum on the forewing merely overlaps the hindwing. In the noctuids, there is a device similar in action to a safety pin.

◁ The European map-winged swift moth, *H. fusconebulosa*, has fine marbled patterning on its wings.

Swift moth

The swift moths are some of the most primitive of living moths. Several features of their internal anatomy are like those found in extinct moths, but the primitive structure of the wings is their most obvious characteristic. Moreover, swift moths are mostly found in Australia where so many survivors from past ages are to be found.

The eight species of swift moths in Europe, five of which live in the British Isles, are small and inconspicuous. They include the ghost moth. Most are 1–2 in. across the spread wings, whitish to pale yellow, some with reddish brown on the forewings. There are three European species that live only on mountains. One species, confined to the Pyrenees, is peculiar in that the female has only vestiges of wings and cannot fly. The majority of the 200–300 species are found in southern Africa, Australia and New Zealand. Some of these have a wingspan of up to 10 in. and are strikingly coloured with intricate patterns of brown, red, green, blue and silver. Although swift moths, especially those with the drab colouring, look like

any other small moth, close examination of their wings reveals two major differences.

The wings of insects are strengthened by what are called veins and in almost all moths the pattern of the veins in the forewings is different from that in the hindwings. The swift moths are an exception: the veining of the forewings is like that of the hindwings, as in the earliest fossil moths. For efficient flying a moth's hind- and forewings must beat together and most moths have a kind of hook-and-eye fastening the wings. Swift moths take us back to the time before this coupling device had been evolved. They have what is called a jugal coupling; that is a lobe or jugum from the forewing overlaps the hindwing, so the hindwing cannot be lifted except at the same time as the forewing. Swift moths are also unusual in having very short antennae and vestigial mouthparts, so the adults cannot feed.

Pests on roots and trees

Since adult swift moths do not feed they are rather short-lived and are mainly concerned with reproduction. In some species the female flies in search of the male, a reversal of the usual courtship behaviour in insects. The life history is not known for

all swift moths but in those that are known, the female drops her eggs at random on the ground and the larvae hatching from them burrow in search of roots, on which they feed. The common swift moth of Europe can be a nuisance in gardens where its larvae attack roots, bulbs and rhizomes of all kinds including root crops and potatoes. On the other hand, the gold swift larva of Europe attacks the roots of the troublesome bracken fern. The larva is white with a brown head and is beset with short, widely spaced bristles. It has the unusual habit of wriggling equally fast backwards or forwards. In New Zealand the larvae of swift moths of the genus *Porina* are known as grass grubs and are a serious pest of pasture land. The larvae of the large Australian bent-wing moth grow to 6 in. long. They burrow in the living wood of eucalyptus trees, seriously damaging the timber. These and other large swift moth larvae are relished by the Australian aborigines, who eat them uncooked, much in the way as some people eat oysters. The pupae of the swift moths are long, unusually active and have spines or toothed ridges on the hind part of the body, which are used in wriggling upwards through the soil.

Eyes, but they see not

Little is known about the enemies of swift moths, but one species has a deterrent against attack. The adult bent-wing moth of Australia has a 7in. wingspan and on each forewing is a large prominent eye-like spot. When the wings are folded back in the resting position the moth looks rather like the head of some animal, complete with staring eyes. From what we know of other insects with eye-spots, it is virtually certain that those of the bent-wing are effective in scaring off birds and other predators.

Insect speeds

It seems a contradiction to call these moths 'swift moths' then to show that their wings are primitive and, by implication, inefficient. They were first called swift moths in 1819, when techniques and instruments for timing the speeds of flying insects were negligible. Most people are content to say swift moths fly swiftly. But they fly at dusk or after dark, so this may be no more than an impression of speed. The question remains, therefore, what speeds can we credit to swift moths? Frank Lane in 1955 listed the speeds of a large dragonfly at 55 mph and that of a hawk moth at 33 mph. He also quoted the opinion of CH Curran suggesting these might be underestimates. Harold Oldroyd, writing in 1968, quotes B Hocking who thinks the maximum speed of flight in any living insect is about 35 mph and that most insects fly much slower.

phylum	Arthropoda
class	Insecta
order	Lepidoptera
family	Hepialidae
genera & species	<i>Hepialus lupulinus</i> common swift <i>H. pyrenaicus</i> Pyrenean swift <i>Leto staceyi</i> bent-wing, others

Swordfish

Although placed in a separate family the swordfish or broadbill resembles the sailfish (p. 2128) in many of its habits, but differs somewhat in appearance. It also is beautifully streamlined with the upper jaw carried forward into a sword-like beak, flattened from top to bottom and oval in section. The front dorsal fin is high, short at the base, and curves backwards. There are no pelvic fins. The first anal fin is fairly large and both the second dorsal and second anal fins are very small and set far back. The body is flattened from side to side and is a dark purple-blue on the back shading to silvery-grey on the underside. The sword is black above, paler on the underside. The fins are dark with a silvery sheen. Like the sailfish the swordfish is reputed to reach a length of nearly 20 ft and a weight of over 1 000 lb. Alwynne C Wheeler, in his recent book The Fishes of the British Isles and North West Europe, gives the maximum length as 16 ft and a weight of over 1 000 lb for the Atlantic and 1 500 lb for the Pacific swordfish. The more usual size is, however, between 6 ft and 11 ft, with a weight between 100–300 lb.

The swordfish ranges through all tropical seas, wandering into temperate seas in summer. It seems to enter temperate seas more than the sailfish, as shown by its being 'not infrequently' seen off the Atlantic coasts of Europe. Moribund swordfish sometimes reach the North Sea.

Warmblooded fish

Swordfish are mainly solitary, occasionally seen in pairs, more rarely in groups, and even then there is usually 30–40 ft between the individuals. When swimming at the surface the high dorsal fin and the tip of the upper lobe of the crescentic tailfin project above water. Although no tests have been made on it, the swordfish is credited with similar speeds to those of the sailfish. It also has sieve-like gills giving a large surface for absorption of oxygen. In most fishes the amount of blood in the body is less than in the higher vertebrates and it flows sluggishly through the arteries and veins. In the swordfish, as in the sailfish and other fast fishes like the marlin and tuna, there is abundant blood in the body, which is comparatively warm. This is linked with the active life they lead. The swordfish not only swims swiftly but can take enormous leaps out of the water. It does the same when hooked and will sometimes circle the boat with only its tail in the water, thrashing it to foam as it drives its nearly vertical body skittering over the water.

Sword kept for cleaving water

The food of swordfishes and their methods of catching prey are like those of sailfishes. Smaller fishes such as herring, sardines, mackerel, bonitos and albacores are snapped up, and swordfishes are also said to swim round small shoals striking out with

the 'sword' and then eating dead and stunned fishes at leisure. The stomachs of captured swordfishes have been found to contain remains of squid and of fishes that live in deep water and on the bottom. It has been suggested that the males fight with their sword-like beaks or attack larger animals such as whales. One celebrated story left us by a certain Captain Crow tells of a large whale being attacked simultaneously by thresher sharks and swordfishes but as killer whales are sometimes called swordfishes, because of the somewhat sabre-like dorsal fin, they are more likely to have been the culprits. The sword probably functions as a cutwater, for use in high-speed swimming, and secondarily as a weapon for catching food, as described above.

Terrible babies of the sea

Spawning takes place in the open sea, in water of 24°C/76 F or more, from February to April in the tropical Atlantic and from June to August in the Mediterranean. The small eggs float and hatch in 2½ days. The baby fishes follow much the same development as in the sailfish except that they are covered with small round warts arranged lengthwise. The function of these outgrowths is obscure, but they disappear when

the adult shape is reached. Baby swordfishes feed in waters down to 96 ft, largely on the larvae of other species of smaller fishes which are prolific in these waters.

Rich livers

The flesh of swordfishes is firm, greyish-white, of a rich flavour, and the oil from their livers is said to have a high medicinal value. The fishes are harpooned for commercial purposes. It is also taken in the tuna traps set up by fishermen.

Terrible giant of the sea

The idea that the sword of a swordfish is an offensive weapon was fostered largely by the way, from time to time, this sword has been found embedded in the timbers of ships. If, however, there is a fish with a sharp beak on the front of its head and it is able to swim at 60 mph, there are bound to be times when such a fish will collide with something, such as a ship, whale or another large fish. Nevertheless, it was the finding of these broken-off swords that earned the swordfish the name of terrible giant of the sea. What is more interesting is the extent of the damage caused by the sword and the force required to do it.

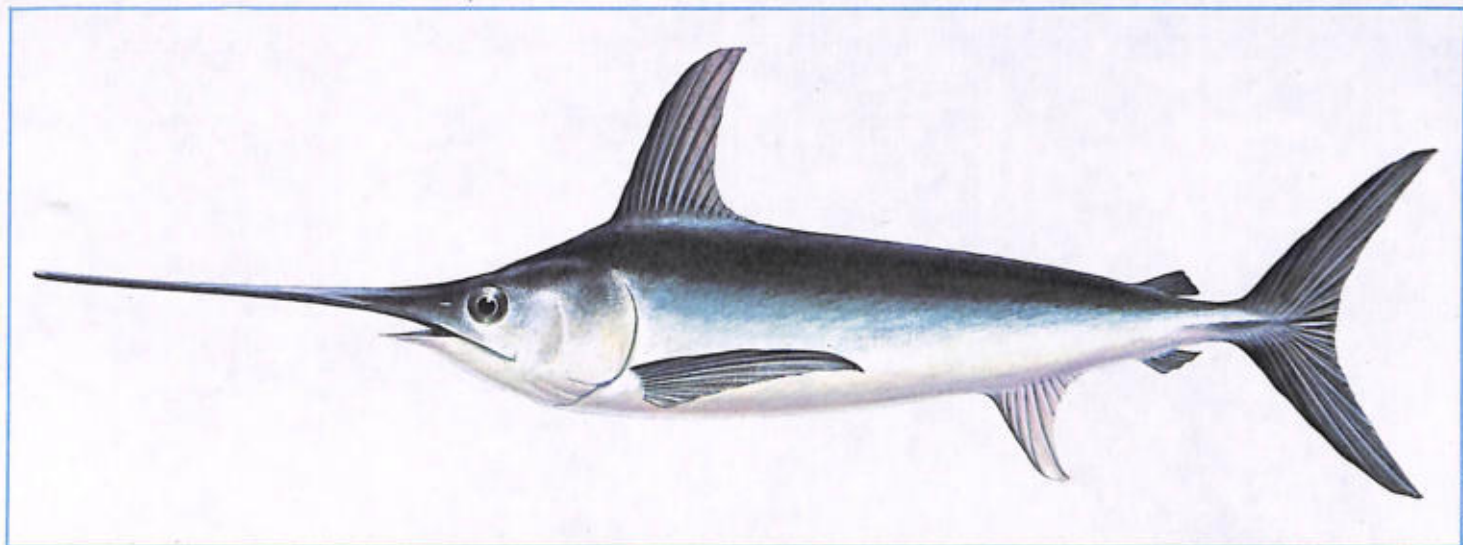
The great American bibliographer and collector of natural history curiosities, Dr EW Gudger, brought together as many examples as he could find of 'attacks' by swordfishes on ships. For example, he listed the ship off Brazil struck one night with such force that the helmsman had difficulty in keeping the ship on course. Another on his list was a ship off the Azores hit so hard the crew thought she had struck a rock. One of the more remarkable cases was that of the whaler 'Fortune'. When she reached harbour at Plymouth, Massachusetts in 1826 she had the sword of a swordfish in her hull that had penetrated a copper sheathing, 4 in. of board, solid oak a foot thick, 2½ in. of hard oak ceiling plank and the head of an oil cask. There are many similar examples. Sir Richard Owen, giving evidence in a case of damage by swordfish in 1868, said a swordfish would strike with 'the accumulated force of 15 double-handed hammers, . . . velocity equal to that of a swivel shot . . . as dangerous in its effects as a heavy artillery projectile.

Sir James Gray once made the comparison that a 600lb swordfish travelling at 10 mph running into the side of a ship would hit it with the force of one-third of a ton per sq. in. It would be the equivalent of the blow of a 10lb sledgehammer meeting a ship travelling at 80 mph. Moreover, if a 600lb swordfish travelling at 10 mph were to meet a ship travelling towards it at 10 mph, the force of the impact would be equal to 4½ tons per sq. in. A swordfish is thought to travel at times at 60 mph, although it is unlikely that this speed would be maintained for long periods of time.

In spite of all that is said here, scientists believe that swordfishes sometimes go berserk and attack deliberately. Whether this was true of the man mentioned in Daniel's 'Rural Sports' is not known. This man, in the River Severn, near Worcester, England, was 'struck, and absolutely received his death wound through a swordfish'.



Peter J Green



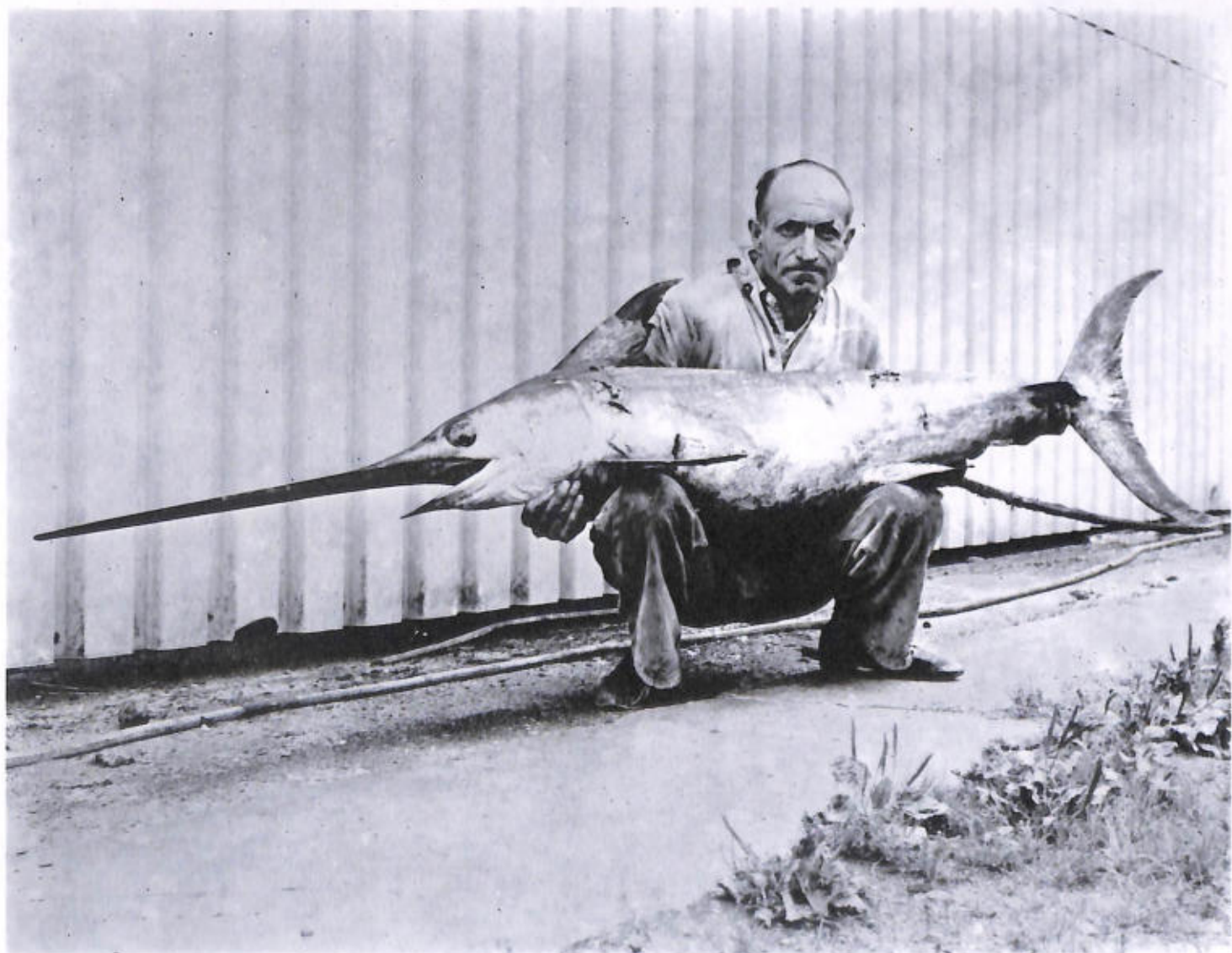
Malcolm McGregor

△ All of the billfishes in the family Xiphiidae have long nose extensions, but the swordfish develops it to the extreme. The sword may be up to one third the body length. It is flattened, rather than rounded like those of other billfishes—giving it the common name of broadbill.

◁ Evidence of attack: part of a ship's timber showing the extensive damage caused by a swordfish.

▽ An unusual catch: Mr E Leathers and the 6ft swordfish he caught in the river Ouse in England in 1969. Swordfishes are usually found in tropical and warm temperate seas but like turtles they sometimes venture north. The world record measured 15 ft and weighed 1 182 lb.

class	Osteichthyes
order	Perciformes
family	Xiphiidae
genus & species	Xiphias gladius



Deryk Story



Swordtail

The swordtail is one of the more important as well as most popular of aquarium fishes, not only for its beauty but because it is a good subject for selective breeding. Swordtails are live-bearing tooth-carps, so they have the shape of that family. The dorsal fin is relatively large and so is the tailfin which is broad-based and rounded at the rear edge. The pelvic fins are at about the middle of the body. The females are up to 5 in., the males being up to 3½ in. exclusive of the sword, which is formed from much elongated rays of the lower part of the tailfin. The outstanding feature of the swordtail is its colours.

Swordtails have been bred in so many colours and colour variations that a description of these in a small space would be impossible. What follows here can, however, be taken as a sort of standard colouring, the one most likely to be seen. The back is olive-green shading to greenish-yellow on the flanks and yellowish



Toni Angermayer

on the belly. The scales are edged with brown so the whole body seems to be covered with a fine net. The fins are yellowish-green, the dorsal fin being ornamented with reddish blotches and streaks. From the tip of the snout to the base of the tailfin runs a rainbow band of colour made up of zigzag lines of carmine, green, cinnabar, purple or violet. The sword of the male is yellow at the base shading to orange, bordered with black above and below.

Swordtails live in the fresh waters of southern Mexico, Belize and Guatemala in Central America.

Bullying males

As is usual with popular aquarium fishes more is gleaned about their way of life from individuals kept in tanks than from those living in the wild. They live the usual uneventful lives of small fishes, most of their time being taken up with searching for food—or bullying each other. Their mouth is inclined slightly upward making it easy for

them to take any food floating at the surface. They can also search on the bottom, the body held almost vertical with the head downward. They also snap at small swimming invertebrates. They are, in fact, omnivorous, taking anything small, both plant and animal, swimming or floating, and in the aquarium they spend much time grazing small algae growing on the glass or stones.

There seems to be a strong social hierarchy known as peck order in a community of swordtails which reveals itself in the aquarium by one of the males tending to bully the rest. Indeed, these fishes seem to be unduly spiteful, especially in small aquaria. Dominance in a community of any species is decided and maintained by fighting, or at least, by aggressive displays, and is closely linked with the strength of the sex hormones. Experiments with swordtails have shown, however, that a female maintains her position in the social hierarchy for 1–3 months after being spayed and a castrated male retains his for 1–6½ months. This is unusual because as a rule, when the gonads are removed, and with them the sex hormones, the individual usually drops more or less immediately to a subordinate rank in the social hierarchy.

△ A male hybrid swordtail with a black-edged yellow 'sword' swims alongside a female.

◁ The male green swordtail, surrounded by red and green swordtails, began life as a female.

Mystery of sex-reversal

Swordtails first became aquarium fishes about 1910, and not long after this the idea began to be current that these fishes undergo a remarkable sex-reversal. In 1926 Essenberg reported that females, after having had several broods, may become fully functional males. From the many reports that followed this the impression is gained that this is commonplace. There have, for example, been several authoritative books on freshwater or aquarium fishes written during the years since Essenberg's report was published, and all have given prominence to this idea. Gunther Sterba in his book first published in 1959 speaks of the quite remarkable and always astonishing sex-reversal in swordtails. He claims that in some strains as many as 30% of females later change into males. Yet in 1957 Myron Gordon, who had made a special study of the species, had already claimed that such

changes were extremely rare, quoting a substantial report on swordtails by Friess, in 1933, in support of his claim.

Subjects for heredity study

If the supposedly remarkable sex-reversal is still in doubt there are other aspects of the breeding for which we have more reliable information. Swordtails have been almost domesticated and by selective breeding a wide range of colour varieties exist, usually named according to their colours, such as the green, the red, the red-eyed red, the red-wag, the black, the golden, and the albino. According to Dr Myron Gordon, quoted by William T. Innes, there are wild specimens comparable to all the selected varieties produced up to 1935 except the golden. There have, however, been others since then, including the one seen below.

Swordtails have been much used for the study of genetics, by crossing the colour varieties. In addition many hybrids with the platy (p. 1929) have been produced, increasing still further not only the range of colours but also the materials for further studies on heredity. These fishes are particularly suitable for laboratory work of this kind. The sexes can be readily recognized,

which is always a help in such studies. The males not only differ from the females in having the 'sword', they also have a gonopodium for the insertion of milt, fertilisation being internal. They also breed rapidly. A brood may number up to 200, each $\frac{1}{4}$ in. long at birth. The newly-born must rise to the surface for air to fill the swimbladder after which they can swim well and start to feed almost immediately. They also grow quickly. At first the sexes look alike but soon the males start to grow a sword. Swordtails live 2–3 years, so there is a rapid turn over in populations. As a result swordtails, with their near relatives the platys, may be considered as a vertebrate equivalent of the fruit fly for genetical studies.

Hybridization

Probably the most remarkable feature of the sex life of the swordtail is the ease with which it hybridizes with platys in aquaria, yet although both species live virtually side by side in the fresh waters of Mexico and Guatemala no wild hybrids have been found. This is the more noteworthy since their breeding behaviour is so similar. There are, however, several small differences,

hardly noticeable until close and critical study is made of them. To begin with, platys take about 5 minutes from the start of pre-mating behaviour to the actual mating, whereas swordtails take only one minute. The actual mating takes only half the time in platys that it does in swordtails and altogether the mating behaviour of platys is much the more vigorous. The differences are slight, and probably no one of them would be sufficient to form a barrier between the species, but taken as a whole they do. Under artificial conditions, as in an aquarium where the choice of mates is limited anyway, the barrier is readily overcome. In the wild, with a wide choice of mates, even small details count.

class	Osteichthyes
order	Atheriniformes
family	Poeciliidae
genus & species	<i>Xiphophorus helleri</i>

▽ *Selective breeding results in a wide range of colour varieties: a recent breed is seen here.*



Tachina fly

Tachina is from the Greek for swift. Although the family name for tachina flies is Tachinidae an alternative sometimes used is Larvaevoridae, or larvae eaters. This describes the flies even better because all pass their larval stage as parasites in the larvae of other insects including butterflies and moths, bees and wasps, bugs and grasshoppers. Some also parasitize spiders, centipedes and woodlice.

Adult tachinid flies are not easy to tell apart except by those who make a special study of them. They are mostly the size of houseflies and bluebottles, are coloured grey, brown or black and are very bristly. Many have a characteristic attitude at rest, with the wings half open and so at right angles to each other. They also have a fussy, inquisitive sort of flight that has been compared to a small dog questing to and fro to pick up a scent. This, indeed, is exactly what the females are doing when they are searching for victims in which to

place their offspring. Tachinid flies are closely related to the Calliphoridae, the family including blowflies (p. 378) and bluebottles, and members of the two families can only be distinguished by reference to obscure details of anatomy.

Tachinid flies have a world-wide distribution and are very numerous. The adults fly actively, some in sunshine, others in shady places. Many feed on nectar, helping to pollinate the flowers they visit. One species *Dexiosoma caninum* a long-legged, bristly yellow and brown fly, is often to be seen in summer in woods in Britain sitting on bracken, and seldom anywhere else. They are of great importance as a natural check to the numbers of the insects which they parasitize. Many of them are not at all particular in their choice of host and deposit their eggs or their larvae in a wide range of insects' larvae belonging to many different orders. Some, on the other hand, seem to have narrow preferences. The species of one genus *Crocota*, for example, confine their attentions mainly to the 'leatherjacket' grubs of craneflies.



Anthony Bannister: NHPA

△ Life and death in the insect world: a tachina fly larva emerges from the body of a moth caterpillar that was about to pupate.

▽ A tachina fly investigates a moth's cocoon.



Cyr Color Agency

Several ways, only one end

The female tachinas lay their eggs in four different ways. In some species they scatter the eggs over plants in places where they are likely to be eaten, accidentally with its normal food, by a caterpillar or some other plant-eating insect. These eggs must be minute and very numerous to be swallowed undamaged; one female may lay up to 6 000 eggs. These hatch in the intestine of the host. In other species the eggs are laid in places likely to be frequented by the host. They hatch quickly into active larvae which bore their way into the skin of any suitable insect that comes along. While waiting, these minute larvae are protected from drying up by a covering of hard plates. The third way is for the female to lay her eggs on the skin, or stick them to the hairs, of the host. When the larvae hatch they bore through the skin into the host. In the fourth method the female tachina punctures the skin of the host and lays an egg which hatches as it is laid, so that a newly hatched larva is easily introduced into the host's tissues.

The last method comes very close to the way the ichneumon wasps (p. 1294) insert their eggs into the host by means of an ovipositor. Tachinas which use the third and

fourth methods lay relatively large eggs, up to 200 in number. In some tachinids only a single larva develops inside each host.

Inside the host the tachina larva is faced with the problem of how to breathe. When very small it can absorb oxygen through its skin from the host's blood, but later it must make a hole in the victim's skin or perforate one of its main tracheae or internal breathing tubes, to gain direct access to air. The parasite then attaches its rear end to the breathing hole so made.

Parasite eats parasite

Among the enemies of tachinid larvae are other insect parasites. An ichneumon wasp may lay its eggs in a host already infested by a tachinid larva. Usually the ichneumon grub eats the tachina larva as well as devouring the vital organs of its doubly parasitized host. There are even some chalcid wasps (p. 544) that can only develop in a tachina larva already feeding inside a caterpillar.

Biological control

Tachinid flies, as well as chalcid and ichneumon wasps, are the living tools for biological control so often advocated as a desir-

able alternative to the widespread use of insecticides. Some have already been cultured artificially to control the numbers of insect pests, especially those that have been introduced into parts of the world where they are not native. Two European species of tachinids, *Comptosia concinnata* and *Sturmia scutellata*, have been imported into North America to help control the numbers of the gypsy and brown-tail moths, themselves both accidental introductions from Europe, and pests of trees. Control of the brown-tail has been particularly successful.

phylum	Arthropoda
class	Insecta
order	Diptera
family	Tachinidae (Larvaevoridae)

▽ *A gruesome sight: tachinid larvae devour a Ceratogyrus spider which was initially paralysed by a pomalid wasp as a host for her eggs, but a tachina fly laid her eggs on the spider before the wasp could bury it.*

▷ *A gentler side: a bristly South African tachina Dejeania bombylans feeds on nectar.*



Anthony Bannister: NHPA



Anthony Bannister: NHPA

Tahr

Tahr are stocky, shaggy animals, related to sheep and goats but with odd characters of their own. They have long tufts of hair on the elbows and jaw, but no beard. Their horns are short and conical but strongly compressed and curved backward.

The females are only slightly smaller than the males, and their horns are similar in shape and size. Like goats, they have no glands on the face or between the hoofs, but there are glands under the tail in the male, which give off a strong smell, especially in the breeding season. The smell of the tahr is, however, not exactly goaty, but is likened by some authors to that of cormorants and frigatebirds.

The three isolated populations of tahr represent distinct species. The Himalayan tahr is deep brown with a dark face and dorsal stripe, 36–40 in. high, old males weighing 200 lb. It is heavily built with long shaggy hair on the foreparts reaching to the knees. Its ridged horns, 12–15 in.

long, have a strong keel along the edge.

The Arabian tahr is sandy, with a black face and black tips to the dorsal crest, only 24–26 in. high and more slenderly built. It has no mane although the hair is longer in winter. The horns are less strongly ridged.

The Nilgiri tahr is the biggest species, 39–42 in. high with a short rough coat. It is dark yellow-brown, paler below, becoming dark with age, old males being nearly black, with a distinct light 'saddle' on the back. The horns have little or no keel, being rounded in front. The females are unique in having only two teats instead of four like the other two species.

Bare subsistence

Like goats, tahr live in mountainous country, mostly in high precipitous mountains. Himalayan tahr are described as the most inaccessible of all wild goats. They live in the most craggy and precipitous places, but never above the tree line (10–12 thousand ft). They prefer rocky areas where there is some scrub and forest nearby; the females

and young often come out to graze in clearings and on open hillside, but old males are said to be solitary, and to live in the thick mountain forests of oak, ringal and cane, emerging only in the evenings. They associate with the herds of females in March and April, when the tahr go down into the valley bottoms to feed on the fresh young grass that has sprung up underneath the melting snow. Then, when the herds return higher up the mountains, the old rams resume their solitary way of life.

Nilgiri tahr inhabit less elevated but equally precipitous areas, at 4–6 thousand ft, where they live largely above the forest line. By day the herds go up to the mountain tops to graze, returning to the forests at night. As in the Himalayan species, old males are solitary, at least in the summer. Nilgiri tahr are nowadays rather rare due to overhunting, but a recent expedition was able to count 292 head, and estimated that there were about 400 in the Nilgiris, with more in the Anaimali Hills and in the Western Ghats. The biggest herd seen consisted of 38 and included several old males.

Arabian tahr live in considerably less fertile country, the mountains of Oman.



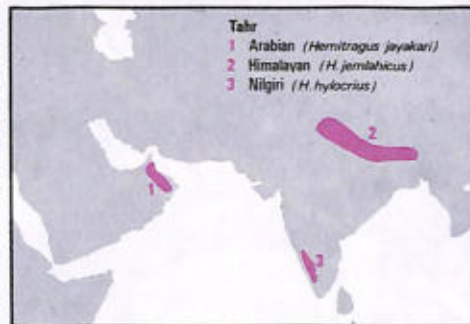
Jealousy is blind

At the end of autumn the breeding males rejoin the herds of females, and begin to fight among themselves so fiercely they seem to lose their usual caution and sure-footedness and some are killed by falling. There is some doubt whether tahr are polygamous or monogamous. A single lamb is born in summer after about 6 months gestation, the rams leaving the females' herd at this time.

Flourishing aliens

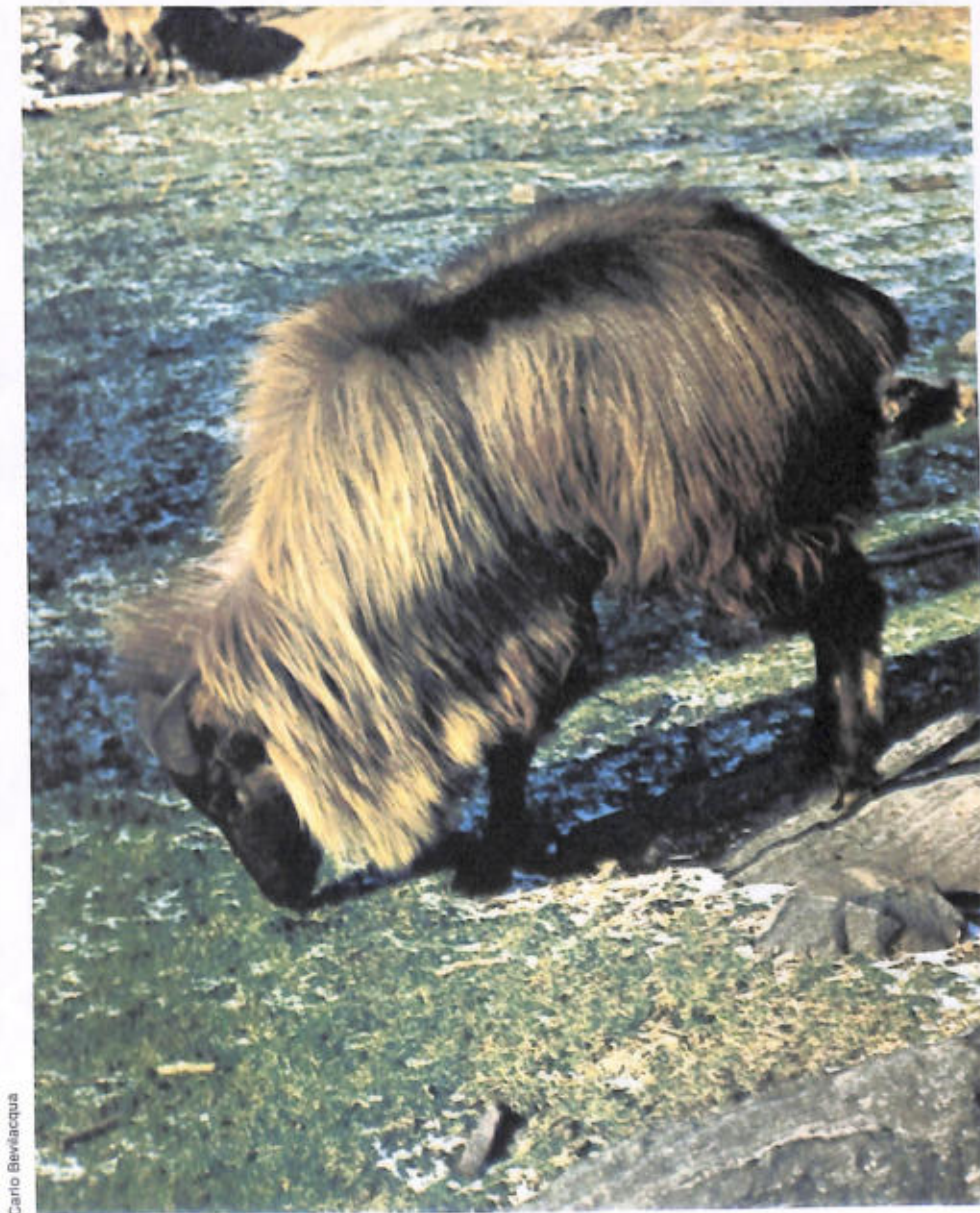
While Nilgiri and Arabian tahr have to be rigidly protected, the Himalayan tahr flourishes, both in its natural habitat and elsewhere. Some 40 years ago a pair were sent from Pretoria Zoo to Groote Schuur estate on Table Mountain, where they were enclosed in a paddock. Undaunted, the pair jumped over the 5ft fence and escaped. Today, their descendants number about 50, living on Table Mountain; they seem to have taken to acorns as one of their staple foods. Visitors seeing them marvel at their sure-footedness, jumping as much as 30 ft downwards to narrow ledges and leaping across ravines with great ease.

In 1904 the Duke of Bedford gave the New Zealand government three pairs of tahr, but one male was lost overboard on the journey. In 1909 eight more (six of them males) were sent, and a few more have been added since. These animals were released near Mt Cook, on South Island and have gradually spread—at the rate of 1.1 miles per year—and today they occupy much of the Southern Alps. Interestingly, they have adapted themselves perfectly to the reversed seasons of the southern hemisphere. They still mate in the winter, although it is May and June in their new habitat, and give birth in the summer (December). The habitat does differ, however, from that of the Himalayas. It is more snowy, and considerably more fertile. For this reason the tahr are found at lower altitudes during the winter, and they also grow to larger sizes: old males of 300 lb are known; the ewes reach only 100 lb or so. Although the population is expanding and successful, natural selection still takes its toll; 80% of each year's young tahr die by the end of the third winter, only 20% surviving to breed. This is an example of another introduced animal adapting successfully to a new environment.



class	Mammalia
order	Artiodactyla
family	Bovidae
genus	<i>Hemitragus jayakari</i> Arabian tahr
& species	<i>H. jemlahicus</i> Himalayan tahr <i>H. hyllocrius</i> Nilgiri tahr

◁ Family gathering of Himalayan tahr. Only the male has the long, heavy mane of hair covering his shoulders, throat and chest.
▽ Male Himalayan tahr grazing. For nearly 10 months of the year old males remain solitary.



Carlo Bleviacqua

Jean Philippe Varin - Jacana



Tailor-bird

The tailor-birds are warblers, for which there is a separate article, but their nesting habits, from which they get their name, are sufficiently interesting for the tailor-birds to have their own entry.

There are two genera of tailor-birds which are only distantly related. In southern Asia, from India and southern China to Java and the Philippines, there are the tailor-birds of the genus *Orthotomus*. Like all warblers, the nine species have inconspicuous plumage. The long-tailed tailor-bird is one of the most widespread. It is 5½ in. long with a long bill and a long tail, which is carried erect like that of a wren. The upperparts are olive-green with orange on the top of the head and whitish underparts. The black-necked tailor-bird is similar but has grey sides to the head, yellow edges to the wings and a black throat in the male.

In Australia there is the golden-headed fantail-warbler or tailor-bird genus *Cisticola* that lives in many parts of northern and eastern Australia. This has a typically warbler appearance with a fine, pointed bill and a fairly short tail. It is 3½ in. long with a sombre, brownish plumage, white underneath. The male has a golden crown during the breeding season but this becomes striped like that of the female for the rest of the year.

Monotonous songsters

The long-tailed tailor-bird is a common garden bird in many parts of lowland southern Asia. It can be seen all the year round flitting among the undergrowth in overgrown plantations and woodland. Its call is a monotonous, shrill 'chee-wit' that is repeated over and over again until it becomes extremely boring and annoying. The call of the black-necked tailor-bird is also irritating but the ashy-naped tailor-bird has a pleasant song of the sort that one expects to hear from a warbler. Another species is the ashy tailor-bird that lives around mangrove swamps.

The Australian tailor-bird has rather similar habits. It lives in swampy country or among agricultural crops and has a buzzing, rather monotonous song. Outside the nesting season the tailor-birds gather in flocks. Both Asian and Australian tailor-birds feed entirely on insects—at least there seem to be no records of their feeding on berries as do some other warblers. The food of the Australian tailor-bird includes grubs and butterflies.

Well lined nest

In some parts of Asia, such as Ceylon, tailor-birds nest all the year round, but most clutches are started after the rains when insects are plentiful. The remarkable nest is made of leaves that are stitched together to make a pouch. This is lined with fine material such as kapok or tree cotton, the fibrous covering of reeds that is best known as material used in quilted clothes. The four

eggs are incubated by the female alone but the male helps feed the young on insects and when the female is brooding he passes food to her and she gives it to the chicks.

The Australian tailor-bird builds a similar nest which is lined with grasses. The male is polygamous and mates with several females. He builds the framework of leaves for each female but leaves her to complete the nest, incubate the eggs and rear the chicks.

Riveted nests

Apart from the monotonous song it is only their nesting habits that make the tailor-birds any more interesting than any other small bird of the undergrowth. The construction of the nests is particularly notable because the living leaves are fastened together to form a pouch. It is usually said that they are sewed or stitched together but the process is more like riveting. The tailor-bird punches a hole through the edges of two overlapping leaves then draws them together and secures them by threading strands of fibres or spiders' web through and teasing out the ends to form knots like

the heads of a rivet. The 'rivets' are inserted every ½ in. to make a solid join. The Asian tailor-birds arrange the leaves so that one arches over the top of the nest to form a protective canopy. The number of leaves used ranges from a single large leaf curled over to as many as 45 leaves in the nest of an Australian tailor-bird.

The ashy-naped tailor-bird never stitches its nest but the habit is found in the closely related brown wren-warbler *Prinia rufescens* of southeast Asia.

class	Aves
order	Passeriformes
family	Muscicapidae
genera	<i>Cisticola exilis</i>
& species	<i>Australian tailor-bird</i> <i>Orthotomus atrogularis</i> <i>black-necked tailor-bird</i> <i>O. cucullatus</i> <i>ashy-naped tailor-bird</i> <i>O. sepium</i> <i>ashy tailor-bird</i> <i>O. sutorius</i> <i>long-tailed tailor-bird</i> <i>others</i>

◁ ▽ Two views of a long-tailed tailor-bird and its remarkable nest. The female shown lacks the elongated middle tail feathers of the male. This species is common in the lowlands of southern Asia.



Takahe

The takahe of New Zealand, a flightless bird belonging to the rail family, was thought to have been extinct for 50 years until an expedition led by Dr GB Orbell in 1948 discovered a small colony of them in a lonely valley on the shores of Lake Te Anau on South Island. Since then small parties of scientific observers have visited the valley to watch and film the birds and with rigorous protection by the New Zealand government the population is now thought to number between 200 and 300 birds, scattered in small groups over an area of about 200 square miles of declared sanctuary.

The takahe (the Maori name for the bird) is about the size of a small turkey. It stands 18 in. high and weighs about 5 lb, with a wing span of up to 34 in. It is brilliantly coloured. The base of the strong bill and the large bony frontal shield is a vivid scarlet while the rest of the bill is wax pink, deepening at the tip. The head, neck and underparts are indigo

Lonely habitat

The habits of the takahe are known only from the birds seen on recent expeditions. The lonely and inaccessible valley, 3–4 thousand ft above sea-level, in which the birds live is wet and marshy and covered only with snow-grass which grows in thick clumps to a height of 4 ft. At first the birds were relatively tame and could be approached closely and even netted, but afterwards they became very alert and wary and when disturbed they disappeared swiftly into the scrub with long easy strides lifting their feet extremely high, the tail bobbing at every step. The birds would wade into the water of the lake but were not seen actually swimming. The lake showed little sign of aquatic or animal life and there seemed to be a great lack of variety of food, which probably explained the absence of many other birds.

Takahes have a peculiar call made up of two long deep notes repeated twice, likened by one observer to the braying of a donkey.

Snow-grass only

The takahe has a voracious appetite but feeds entirely on snow-grass, using two methods. Either it will climb into a snow-grass clump and run its bill along the stems

Large spotted eggs

The takahe's nest is made of soft stalks of grass laid to a depth of at least 3 in. between clumps of snow-grass which are bent over it, giving a back and front entrance and sheltering the nest in bad weather. The normal clutch is two and the eggs are large, about 3 in. long and 2 in. wide, dull cream with brown spots and purplish blotches. Sometimes the eggs are almost devoid of speckling apparently due to a lack of sufficient pigment in the female. The young takahe is very similar to a young European coot. It is covered with jet black down with very large purplish brown legs and a black beak with a white tip. It has very marked wing spurs characteristic of the rail family.

Stoat the chief enemy

The takahe's chief enemies are introduced predatory mammals, mainly stoats. The few deer which pass through the valley each year compete with it for food by grazing the snow-grass. Fortunately for the survival of the takahe, the numbers of both the stoat and the deer are now being controlled.

Exciting discovery

The rediscovery of the takahe was one of the most exciting stories of the last quarter of a century and aroused widespread interest throughout the world. The first bones of this bird were discovered by Walter Mantell on Birth Island in New Zealand and were sent to the British Museum and named *Notornis mantelli* in 1848. More bones were discovered in South Island soon afterwards but in 1849 the first living bird was discovered at Duck Cove, Resolution Island by some sealers whose dog caught the bird alive. The second specimen was caught in 1851 by a Maori on Secretary Island. The skins of both of these were preserved and can be seen in the British Museum and New Zealand's Dominion Museum respectively. Nearly 30 years elapsed before the takahe was seen again. In 1879 a rabbitier found one nine miles southeast of Lake Te Anau and this was skinned and subsequently bought by the Dresden Museum where it was named *N. hochstetteri*. Although the takahe was seen or heard from time to time the next specimen was not caught until 1898 by a dog owned by a Mr Ross. This was skinned and preserved at the Otago Museum.

For years the Ross specimen was thought to be the last of the takahes and in spite of rumours of sightings, the bird was said to be extinct by all the reputable text-book writers. Then came Dr Orbell's exciting rediscovery of it in 1948, and the manner in which it was handled by all concerned probably saved it from extinction. For example, the first bird found was netted, photographed and released, with no thought of killing it, as has so often happened in the past with rare specimens.



The flightless takahe feeds on snow-grass, using its strong pink bill to remove seeds and tender grass tips. The bill and scarlet frontal shield contrast sharply with the rich blue and green plumage.

blue, shading into a bright peacock blue on the shoulders and bright sage green on the wings. The rump and tail are a tawny olive with a tuft of white feathers under the short tail. All the feathers have a beautiful silky texture. The rose coloured feet and legs are strong and large. The female is smaller and slightly more drab in colour than the male.

to strip off the seed heads, or it will stand on the clump and hold a portion down with its foot. The heavy bill is then used like an axe to hack out the lowest parts of the clump which are held firmly in the closed foot while the lower tender ends are cut off with the bill and eaten.

As the food of the takahe is mainly fibre its droppings are easily distinguished from those of all other birds.

class	Aves
order	Gruiformes
family	Rallidae
genus	
& species	<i>Notornis mantelli</i>

Takin

The takin is related to the chamois and serow and is grouped with them as a goat-antelope because of its puzzling ancestry. It is heavily built, standing about 3½ ft high and weighing 500–600 lb. It has a convex, ram-like face with a wide, heavy mouth and a thick, massive neck. The muzzle is broad and hairy, with a small, moist, naked portion. The shoulder is slightly humped, the back is arched, with sloping hindquarters and the legs are short and strongly built. The hoofs are large and thick, and there are also big lateral hoofs. The horns are curious; they are fibrous, with thickened bases rather like those of a musk-ox or a Cape buffalo, but the bases are slightly raised above the skull. The horns then turn outwards, and up at the tips.

Takin are found on mountain flanks and in hilly country, mainly in China, in the states of Shensi, Szechwan, southern Kansu and western Yunnan, and over the border into northern Burma, the Mishmi Hills of Assam, and Bhutan. The colour of the coat varies. Generally it is some shade of yellow in the male, becoming blackish on the flanks and haunches and much lighter on the withers, with a dark stripe along the midline of the back. The females are greyish and the young are black. In Assam there is a predominance of reddish animals in one district, yellowish in another; in Szechwan and Yunnan, males are a rich golden yellow in summer, grey in winter. In Shensi and Kansu, the males are more ochre-buff and the females creamy buff, with very little trace of the dorsal stripe. All these variations are, however, merely races of the same species.

Dwellers in high forests

The takin lives in very steep areas, above 7 000 ft, frequenting thick montane forest and especially bamboo and rhododendron jungle, where it makes regular narrow paths through the undergrowth. In summer, takin often emerge from the forest zone to feed in the open 'dwarf bush zone' of the high plateau at 10–13 000 ft. In the Mishmi Hills, takin have been recorded as low as 3 000 ft, but here the country is just as dense and steep as at higher altitudes in China.

In summer takin gather in large herds of up to 300, which probably only collect temporarily in areas of good feed, or round watering places. In winter, they go around in much smaller parties. Bulls are mainly solitary at most times of the year.

▷ The hefty, slightly clumsily built takin has a puzzling ancestry. The thickset body, fibrous horns and large, lateral hoofs are similar to the musk-ox but other features—skull, arched back and lack of glands behind the horns—link it with the goral and serow, thus placing the takin in the little-known group of goat-antelopes.

Fond of hot drinks

Takin are mainly browsers, feeding on twigs, leaves and bamboo shoots. They usually feed in the late afternoon after spending the day in cover, but on cold or foggy days they are active all day. They are very fond of salty-tasting minerals and frequent the small jungle clearings known as salt-licks, where such minerals are found at the surface. They have been known to drink from hot springs.

Slightly polygamous bulls

In western China, the rut takes place in July and August; in Assam, slightly later, mainly in September. At this time the bulls, which have been living alone for most of the year, start moving around with one or more cows, and they become very aggressive towards other bulls. The young are born the following year, in March to April in China and in May in Assam, after a gestation of 200–220 days. The cow enters the thick forest to give birth, rejoining the big herd with the calf after several days.

Age unites them

The takin is something of a mystery animal for zoologists. Remains have been found in Pleistocene deposits in China, that differ little from the living animal. Several recent experts on the Bovidae have proposed that the closest relative of the takin is the musk-ox. Both are stockily built, with strong, thick limb-bones and somewhat similarly shaped, fibrous horns. In both, also, there are no face-glands, nor glands behind the horns as in the chamois, and the lateral hoofs are very large. Against this others have pointed out that the takin lacks numer-

ous characteristic features of the musk-ox, like the asymmetrical hoofs, the long coat and the sway-back—concave spine—which is very different from the convex back of the takin. They point out also that when the much heavier horns are taken into account, the skull of the takin very closely resembles that of the goral and serow which also lack the glands behind the horns, a feature that differentiates them from the chamois.

The only thing one can say for certain is the takin belongs to the little-known group of Bovidae which are nearly related to the sheep and goats, and which are not as slender and graceful as the somewhat mixed group we call 'antelopes'. The problem is solved by calling them 'goat-antelopes'. The serow and goral are the most slenderly built of the goat-antelopes and have small glands in their feet. The chamois and Rocky Mountain goats are heavier, with stouter limbs, but they also have foot-glands, and glands behind the horns. The takin and musk-ox are the other members of the group. The whole curious assemblage are an old, relict group, found either in mountainous regions or, like the musk-ox, in the far north. Most of the living forms seem to have their own long, separate history, and have gradually been forced into smaller and smaller areas due to competition from their more successful cousins, the sheep and goats.

class	Mammalia
order	Artiodactyla
family	Bovidae
genus & species	<i>Budorcas taxicolor</i>



Jean-Philippe Verin; Jucana

Tamarin

Tamarins give us a natural study in matching colours. Although all the small clawed South American monkeys are loosely referred to as 'marmosets', strictly that term should be applied to only the common and pygmy marmosets and their relatives (see p. 1557). The others should be called tamarins. There are two genera and 17 species, which are all very distinctive and easy to distinguish.

They differ from true marmosets mainly in their teeth, the canines being long and the incisors short, instead of both being about equal in length like the teeth of a comb, as in true marmosets. Tamarins weigh 9–18 oz, and are usually 6–10 in. long, with a tail of 10–16 in.

The black tamarin, found on both sides of the Amazon estuary, is black, marbled with buff, but one race has golden hands and feet. The black and red tamarin, of the Colombia-Ecuador-Brazil border, is black or marbled on the foreparts, red-brown on the hindparts, with white hair around the mouth. The closely related brown-headed tamarin varies in colour but usually has a marbled 'saddle' separating its reddish foreparts from the darker hindparts. The red-bellied tamarin has a white moustache with pink skin beneath it and a black-brown back which contrasts with a red underside. Related to this are the yellow-brown moustached tamarin, in which the white hairs cover the lower part of the nose, and the fascinating emperor tamarin which has a long 'handlebar' moustache, and is grey with a red tail. Other tamarins have almost hairless faces. The pied tamarin has big, bare ears, whitish foreparts and brown to black hindparts. Schwarz's tamarin is black with yellowish flanks. The white-footed tamarin has a short crest on the forehead and is brownish-grey with white hands and feet. The Pinché or cottontop has a long crest like a Red Indian warrior and is dark brown with a white belly and limbs. All these forms are found in the middle and upper Amazon region of Brazil and Colombia, except the last, which is found in northern Colombia and Panama.

Rather different are the larger lion marmosets (or tamarins) which have long, narrow hands and feet and rather shorter tails, and long silky manes on the head. They are found in the drier, hardwood forests of southeast Brazil. The golden lion marmoset is a beautiful red-gold, the black and gold lion marmoset is black with a golden mane and arms, and the golden-rumped lion marmoset is black with a golden forehead and rump-patch.

▷ The tamarin's long, curved claws help it to climb easily. The first toe, however, has a flat nail instead of a claw and is opposable.

Inaudible high notes

Tamarins live on the larger branches of trees at all levels in the South American forests. They are very agile, often jumping from branch to branch, and clinging on by their claws. Most species seem to live in mated pairs with their young. They are strongly territorial, the females especially being very aggressive towards other groups. Tamarins mark their territory with glands in the genital region and with urine. They also make extremely high-pitched calls, some of them inaudible to the human ear. The black tamarin calls from an exposed branch in the early morning with a high but audible twittering sound. His calls are answered by nearby groups of black tamarin.

The cottontop lives mainly in the upper layers of the trees. The black tamarin, on the other hand, feeds at low levels and goes up into the thicker foliage of taller trees in the heat of the day. This species has been seen to leap 25 ft horizontally, losing an equivalent distance in height, but the cottontop and pied tamarin do not leap. When very agitated, some tamarins stand upright on their hindfeet. They generally groom their mates with their teeth and tongues, and groom themselves by methodical scratching with their claws.

Tamarins eat many kinds of food, including leaves, fruit, buds and insects. Some species are, however, more restricted in their diet. For example, the stomachs of three black tamarins which were examined contained only fruit.

Casual courtship

Tamarins do not seem to be seasonal breeders, or to have long courtship sessions. Invitation to mate seems to be by a ritualised tongue movement. After a gestation of 140–145 days, twin young are born (in 90% of cases). These are generally carried about by the father, being handed over to the mother only for feeding. When small, they are worn like a scarf round father's neck.

Natural colour charts

There is an extraordinary variability in colour among tamarins, not only between species but within species as well. Philip Hershkovitz of the Chicago Natural History Museum has studied the brown-headed tamarin, which is very widespread and especially variable in colour. He found that in its middle-Amazon range there were a dozen or so sharply marked geographical forms—all separated by tributaries of the Amazon. Moreover, there seemed to be a progression of colours from one end of the range to the other. It was possible to reconstruct the development of colour-types, and the history of the distribution of the species, from studying the present-day colour variations. North of the middle Amazon are subspecies which are reddish brown, with a strongly 'agouti-coloured' saddle region—that is, the hairs in that region are alternately banded with black and yellow. Farther west, along the upper Amazon, are forms with less banding, including a beautiful race called *tripartitus* with a black head,



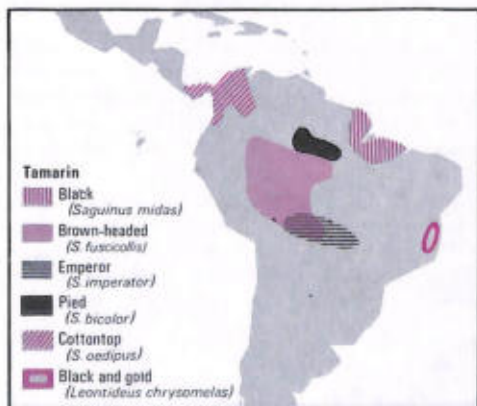
E. Lindsey

a golden mantle on the shoulders, marbled saddle and red-gold hindparts. Turning south and east, across the headwaters of the Amazon and along its south bank, the races become lighter and lighter, with less and less distinction between the saddle and the fore- and hindparts, until finally we end up with a race known as *melanoleucus* which is a washed-out creamy-white all over. To look at it one would not think it could be the same species as the others, but of course it is, connected by intermediate forms.

Looking at this scheme, Hershkovitz theorised that colour-change might be a one-way affair. Starting with the agouti, banded hairs, the hairs lose their bands and become all one colour. The resulting colour gets lighter and lighter until it reaches white, after which the animal can evolve no more in colour and, if required to change by pressures of the environment, cannot do so and becomes extinct. He found similar things happening in other marmosets too: the races of moustached and emperor tamarins, and of silvery and santarem marmosets also showed this progression of colours. In other mammals, he found it occurred among squirrels and other rodents.

Although it has been criticised, especially for its supposition that colour cannot change back into its previous state, this theory makes a very useful way of looking at colour evolution in mammals. Although the genetics of colour in wild mammals is little-explored, the colour-differences between different subspecies are probably very simple, perhaps being due to single mutations; there may be reason for thinking the changes tend to occur in one direction.

class	Mammalia
order	Primates
family	Callitrichidae
genera	<i>Leontideus rosalia</i>
& species	<i>golden lion marmoset</i> <i>Saguinus bicolor</i> pied tamarin <i>S. fuscicollis</i> brown-headed tamarin <i>S. imperator</i> emperor tamarin <i>S. midas</i> red-handed tamarin <i>S. oedipus</i> cottontop or Pinché



▷▷ A brown-headed tamarin father *Saguinus fuscicollis* carries his two young pick-a-back. The babies, nearly always twins, only return to their mother to be fed.
▷ The Red Indian look: the long, warrior-like crest of the cottontop or Pinché tamarin.



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Tanager

There are over 200 tanagers, most of them brilliantly coloured. They are medium-sized birds, 4–8 in. long, related to the swallow-tanager, honeycreepers (p. 1225) and buntings (p. 447). In most species the sexes are alike and display bright patchwork plumages. The most brilliant tanager is said to be the red-rumped paradise tanager *Tangara chilensis*, which is mainly black above and turquoise below with a red rump, purple chin and green head. It is one of about 50 species in the genus *Tangara* which can be considered to be typical tanagers. One of the commonest and the best known is the golden-masked tanager *T. nigro-cincta*. It is mainly black with gold and blue on the head, a turquoise rump and the black of the body is relieved with small patches of white. Another large genus is *Tanagra*, not to be confused with *Tangara*, which are known as euphonias, while tanagers

one or two specimens discovered among skins sent to Europe in the 19th century for the feather trade. Often it is not known from which part of America the skins came. The azure-winged tanager was, however, discovered alive in Mexico in 1937, having been known since 1866 from only a single skin in the Berlin Museum.

The few tanagers that do show differences between the plumage of male and female are those that form flocks outside the breeding season, such as the euphonias, and those that migrate, such as the four natives of North America. The male scarlet tanager *P. olivacea* of the eastern United States has two plumages. In the breeding season it is bright red with black wings and tail but for the rest of the year the red changes to yellowish green, and is similar to the female. North American tanagers migrate to the tropics for the winter.

Fruit and insect eaters

Most tanagers are primarily fruit-eaters but they all eat a certain number of insects; the North American summer tanager *P. rubra* hunts on the wing for flying insects. It also

The nest is usually a cup high in a tree or low in a bush, occasionally on the ground, but some tanagers build globular nests with an entrance in the side and place them in rock crannies and holes in trees. The male usually feeds the female before the eggs hatch but does not help with incubation. The clutch is usually 2 eggs but is larger in the chlorophonias, euphonias and the North American tanagers. The eggs hatch in 12–14 days and are brooded by the female, but both parents feed them. The chicks fledge in 2–3 weeks.

Overzealous parents

The blue tanager *Thraupis episcopus* has unusual nesting habits. Although capable of building its own nest it sometimes uses the abandoned nests of other birds and even usurps other birds' nests. It has been known to take over the nest of a golden-masked tanager and rear its chick along with its own. This seems to be the beginnings of a cuckoo-like habit, but some tanagers seem to have an unusual drive to feed chicks. In the golden-masked tanager and others,



Henze Schiempp



Henze Schiempp

in the genus *Chlorophonia* are usually called chlorophonias and are predominantly green. An unusual tanager is the magpie tanager *Cissopis leveriana* which is black and white.

Most tanagers live in tropical America, ranging from Mexico southwards, but five live in North America. One, the blue-grey tanager *Thraupis virens* with predominantly blue plumage, has been introduced to Florida from tropical America. The others are unusual because the sexes differ; the females are a drab yellowish-green. The males are mainly red except that of the western tanager *Piranga ludoviciana* which nests as far north as British Columbia and has mainly yellow plumage with a red head and black wings and tail.

Elusive birds

Tanagers live in forests, usually in the tree-tops or in bushy areas and clearings. Despite their bright colouring they are not conspicuous, and some are known from only

invades wasps' nests for the larvae and pupae. Other tanagers hunt among foliage for insects and other small invertebrates or pick about in the mats of lichen and mosses that cover trunks and branches of trees. The grey-headed tanager *Eucometis penicillata* joins antbirds (p. 159) and others in following swarms of army ants to feed on the small animals that they disturb.

Euphonias feed in particular on the berries of the mistletoe family which grow parasitically on trees. The seeds pass through the euphonias' bodies without their sticky covering being removed. They therefore stick to branches and germinate when voided, thus spreading the parasite.

Globular nests

Tanagers usually have poor songs and this is probably connected with their very weak territorial behaviour. They do not defend their territories strongly and some do not hold territories at all. Some of the brightest tanagers have virtually no song but others, like the scarlet tanager and the grey-headed tanager, have pleasant songs. Ant-tanagers sing particularly strongly at dawn.

◁▷ Scarlet tanager in bold breeding plumage; he looks like the greenish female at other times.
△ Iridescent splendour: golden-masked tanager.
▷ Fluttering its wings, an aptly-named festive tanager *Tanagra cyanocephala*.

three or four adults have been seen feeding chicks in one nest, so presumably one or two must have been unrelated assistants, and sometimes young tanagers help their parents feed the next brood. The greatest zeal was shown by a red-rumped black tanager *Ramphocelus passerinii* that fed a nest full of chirping sparrows until its own eggs hatched. Even this is well surpassed by the male song tanagers that bring food when the females are away and present it to the eggs.

class	Aves
order	Passeriformes
family	Emberizidae
genera	<i>Cissopis</i> , <i>Eucometis</i> , <i>Piranga</i> , <i>Ramphocelus</i> , <i>Tanagra</i> , <i>Thraupis</i> others



Tapir

Although at first sight they look so unlike, tapirs are related to the rhinoceros on the one hand and the horses and zebras on the other. Their main point of interest is that they have long served as one of the best examples of discontinuous distribution. There is one species in southeast Asia, the Malayan or Asiatic tapir, and three species on the other side of the Pacific, in South and Central America. Although they live so far apart the different species are remarkably alike.

About the size of a donkey, except for its shorter legs, the tapir is about 6 ft long in head and body, sometimes reaching 8 ft, and it stands 29–40 in. at the shoulder. It is stoutly built and weighs 500–700 lb. The snout is prolonged to a short trunk with a pair of nostrils at its tip. The eyes are small and the ears oval, erect and not very mobile. The legs

are comparatively short with four toes on each front foot and three on each hind foot, and all end in small hoofs. There is a very short tail, only 2–4 in. long, and the body is covered in short, bristly, but quite dense hairs.

The Malayan tapir is strikingly patterned with the foreparts and the limbs black and the rest of the body white, making it inconspicuous in its native habitat. Completely black individuals have been recorded from southeast Sumatra but whether these are melanistic individuals or a distinct race is not easy to say. The three species in South and Central America are similar in appearance to the Malayan tapir except that they are dark brown to reddish above, sometimes with lighter colouring on the head and throat. The Brazilian and Baird's tapir have a low, narrow mane, which is not always easy to see. The skin of the mountain tapir is thinner than that of other species.

The Malayan tapir ranges through

Burma, Thailand and the IndoChinese peninsula, to Malaya and Sumatra, and there have been rumours of it occurring in Borneo. The Brazilian tapir lives in South America from Colombia and Venezuela southward to Brazil and Paraguay. The mountain, woolly or Andean tapir is found in the Andes at heights of up to 14 000 ft in Colombia and Ecuador and possibly also in northern Peru and western Venezuela. Baird's tapir ranges from southern Mexico through Central America to Colombia, and Ecuador west of the Andes.

Sensitive snout

Tapirs live in wet tropical forests, always near a good supply of water. They drink a great deal and spend much of their time swimming, splashing about in the water and wallowing in mud like a rhinoceros. They are said to be shy, living alone or in pairs and are seldom seen, as they usually shelter in the forests by day, coming out only at night to feed. They are agile and can run



swiftly when necessary. When disturbed they quickly take refuge in water or rush precipitously into thick brush. Very occasionally they have been known to turn on a pursuer and attack with their teeth or, by rushing violently at it, knocking it down and trampling it. It is, however, usually the female with young that shows this unaccustomed courage.

The tapir has very keen powers of hearing and scent. Its snout is very mobile and sensitive and can be turned from one side to another, stretched out and withdrawn, enabling the tapir to explore a piece of ground of about a foot in diameter without moving the rest of its head. Moreover, because the trunk is so mobile, the nostrils can be applied to the ground at any point within the circle, allowing a very thorough examination of every inch of the ground covered. Then, when it finds something worth eating, it presses the snout into the vegetation and rapidly withdraws the trunk which appears almost to disappear into the muzzle. When it lifts the head again the trunk is extended once more to continue searching for food.

Tapirs make a variety of calls including a distinct clicking noise produced by the tongue and palate, a nasal snort and a shrill squeal made usually when the animal is in danger or pain.

Discriminating browsers

Tapirs browse on aquatic vegetation and the leaves, buds, twigs and fruits of low-growing plants, especially young green shoots. They have been known to damage young cereal crops and they do much harm to crops of sugar cane and melons, especially in Central and South America. They are particularly fond of salt and will make regular visits to the nearest salt-lick.

Patterned young

In all tapirs breeding apparently takes place at any time of the year. After a gestation period of about 13 months they bear one young, rarely two. Young tapirs of all species are dark and distinctively patterned with yellow and white longitudinal stripes and spots on the body and legs, a pattern which usually disappears in 6–8 months. The young tapir is able to accompany its

mother very shortly after birth. The life span of a tapir judged from those tapirs kept in captivity, is about 30 years.

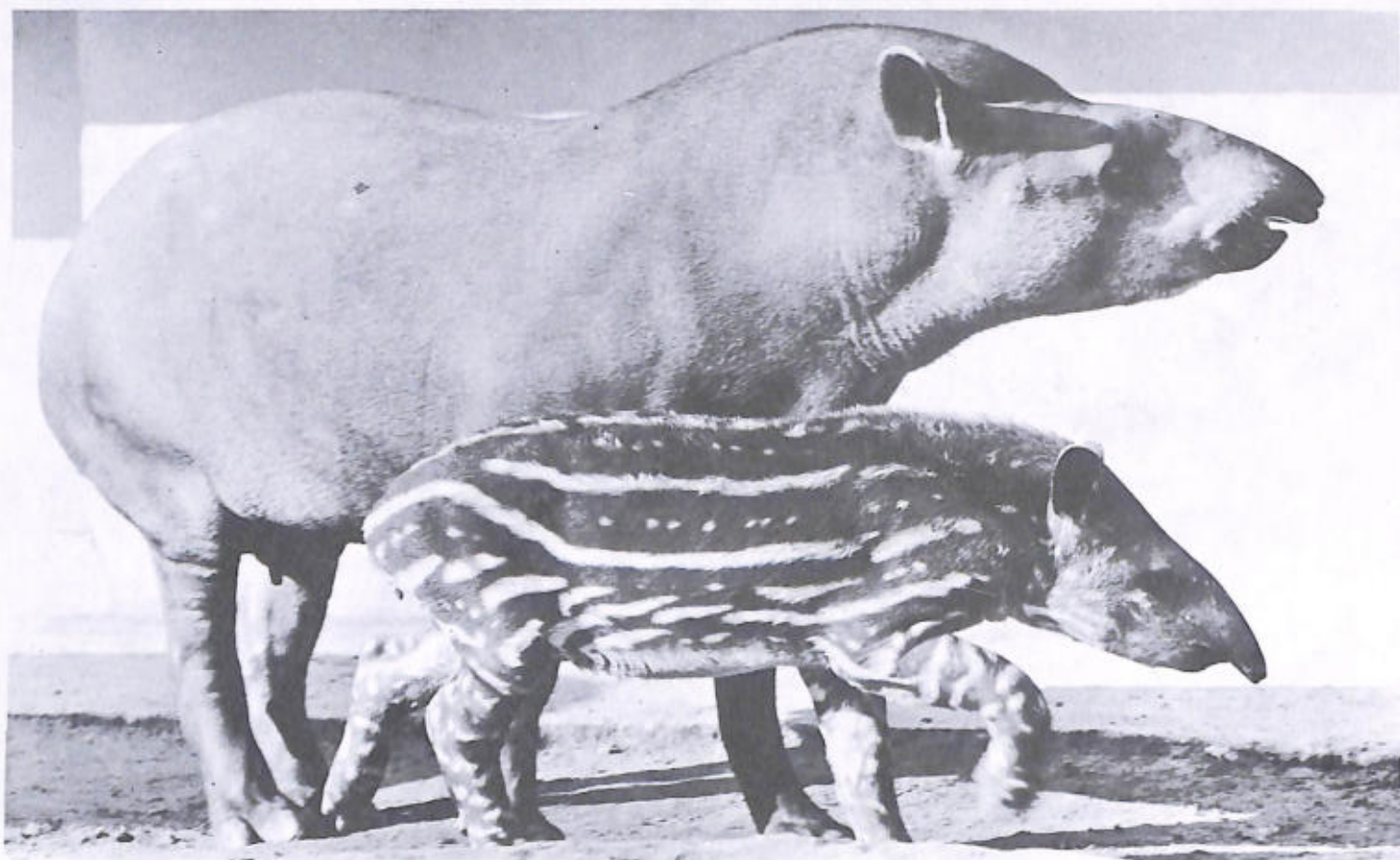
Destruction of habitat

The chief enemy of the Malayan tapir is the tiger, and the New World species fall prey to the jaguar and anaconda. Bears sometimes eat the mountain tapir. In some areas tapirs are hunted for food and for sport. Their main danger, however, in recent times is that the replacement of the evergreen jungle by commercial plantations may cause them to disappear except in closed reserves. This danger is more acute in Asia, where expansion is more rapid than in America.

▽ *Up to its knees in water a Brazilian tapir takes a long, cool look at the muddy bottom.*

Tapirs spend a lot of their time in water, splashing about and wallowing like rhinoceroses, to which they are related. They are also related, surprisingly, to the horse. Tapirs drink a great deal and eat aquatic vegetation as well as leaves, twigs and fruit. When disturbed they rush into the water, being able to swim well, or take cover in dense bush.





roebild



Ivor Jarmann



Popperfoto

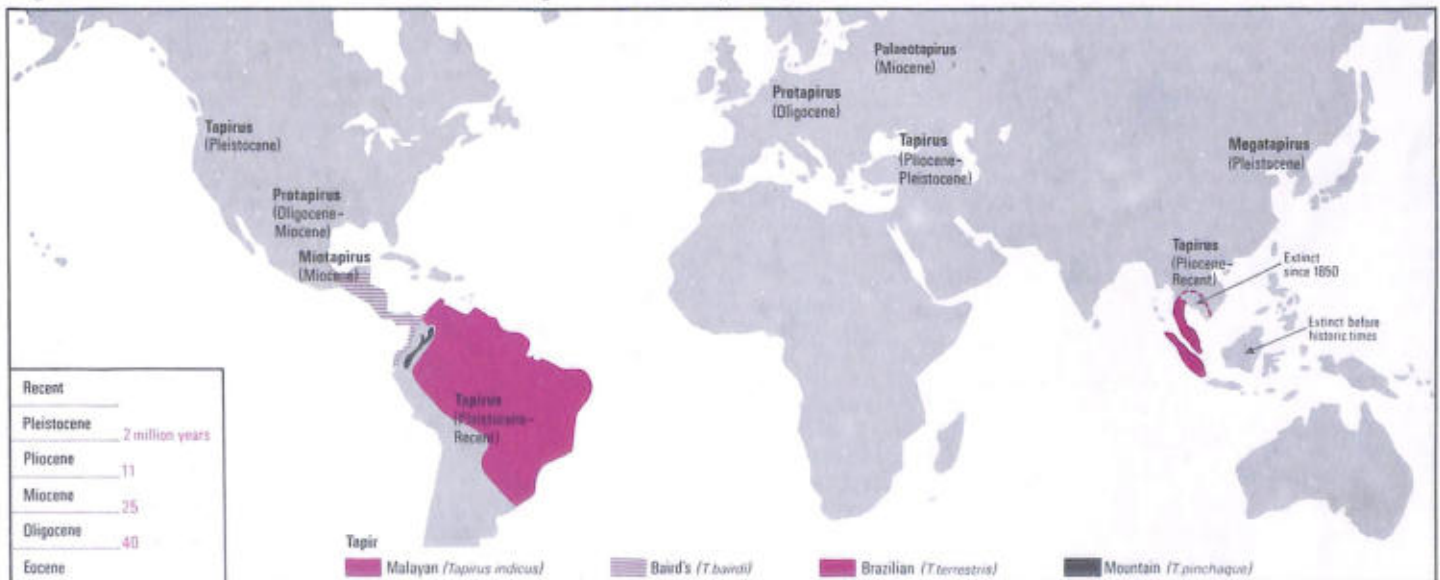
◊ ◊ The stripes of the young tapir grade up through spots to the plain adult coloration.
 ▽ Tapir range—a discontinuous distribution. Past eastward migrations from Europe into southeast Asia, then across the Bering Straits and down into America have been postulated to explain this, but fossil evidence implies a former worldwide range, with smaller-scale migrations and some extinctions.

△ Malayan tapir. Rhinoceros-like, it has three toes—two are visible here—on each hindfoot, all in contact with the ground. On each forefoot, however, it has four, three main digits and a smaller one. This small digit is functional only on soft ground: the animal is walking on its 'middle fingers'. Compare also the snouts; the tapir above is at rest, the one on the left is extended and probing.

Long lineage

Bones of fossil tapirs have been found over Europe and Asia and, also North and South America. The earliest of these are some 50 million years old, and many of them, while obviously of the same family, differed from the tapirs of today. Nevertheless, there were tapirs, very like those we know today, in existence about 20 million years ago. From this widespread distribution they have dwindled until they are now found in two limited and widely separated areas. It is, perhaps, rather surprising that they should have been so widespread for so long, and it is no less surprising that any of them should have persisted until now, for of all the large animals of the world they are probably the most completely defenceless. They are normally slow and deliberate in their movements, habitually with their snouts near the ground and showing little sign of being on the alert for danger. It is possible that the tapir's trunk-like proboscis has contributed as much as anything to its survival. It may, in fact, be a highly efficient sentinel, constantly sampling the air in all directions even while searching for food, as it restlessly twists and turns, with wide-open nostrils. When, therefore, we speak of the tapir as shy, we ought perhaps to say instead that it is highly sensitive to its environment and quick to make its escape. This may be the main reason why tapirs, although of such long lineage and now so widely separated geographically, have undergone so little change: they are so well adapted to life that there is no need for change. So the secret of their survival may well lie in this short but extraordinary trunk.

class	Mammalia
order	Perissodactyla
family	Tapiridae
genus	<i>Tapirus bairdi</i> Baird's tapir
& species	<i>T. indicus</i> Malayan tapir <i>T. pinchaque</i> mountain tapir <i>T. terrestris</i> Brazilian tapir



Tarantula

Although everyone knows that the tarantula is a spider, few people are sure of its exact type; great confusion exists over the name. Originally, it referred to a small spider, belonging to the family of wolf spiders living in southern Italy. Its name was derived from the town of Taranto where legend stated that its bite was fatal unless the patient danced until exhausted, and the poison had been sweated from the system. The dance became known as the tarantella. All this happened in the Dark Ages, possibly earlier, and long before Columbus discovered America. Soon after that discovery the large bird-eating spiders (p. 341) of South America were called tarantulas. Their large size and, to most people, repulsive hairiness epitomized the popular horror of spiders and the image in many people's minds of the dreaded spider of southern Italy. Increasing the confusion, some large North American spiders, spanning 5 in. with their legs, were called tarantulas, although they belong to another family, Theraphosidae, only distantly related to the Italian tarantula. Setting the seal on the confusion, certain harmless whip-scorpions that are not even spiders have been placed in a family named the Tarantulidae.

There are nearly a dozen species of the genus *Tarentula*, including the one that started all the fuss. This used to be known as *Tarantula inquilina*, then *Lycosa narbonensis* and now it is named *Lycosa tarantula*. Its long, somewhat narrow, grey body is just over 1 in. in length, with dark spots, and its legs are hairy and about the same length as the body. Other European species are similar but only just over ½ in. long, or less, and one, *L. fabrilis*, has a dark, dagger-shaped mark on its abdomen.

Spiders, has given a detailed description of what happens in some of them. In two species the male moves his palps up and down, slowly at first, then more quickly, and he begins to pulsate his abdomen. Then he walks around the female with jerky steps, with his front legs bunched up and pulsating both his palps and his abdomen, the latter making a tapping sound on the ground. In a third species the male paws the ground in front of him with his front legs, in the manner of a horse, and then starts to circle the female, getting slowly closer and closer to her. He rears up with his palps pointed upwards and his first pair of legs raised in a curve. He then jerks them upwards before lowering them, trembling, to the ground. The female eventually becomes receptive and the male transfers the packets of semen first from one palp, then from the other, to the female.

hit upon one that set the patient dancing, slowly at first but with more and more speed and vigour—rather like the male tarantula's wooing—until the patient finally fell sweating profusely, exhausted but cured. By that time the whole of his neighbours might be affected and they would take up the dance, and this might spread to other communities.

It sometimes happened that mass hysteria would break out and spread across Europe. The tarantula was blamed for this. By contrast we find Robert Burton, in his *Anatomy of Melancholy* (1621), recommending hanging the spider in a nutshell around the neck as a cure for the ague (malaria). He says he got this cure from his mother but seems to have been doubtful of its value until he found it had been recommended by Dioscorides, Matthiolus, Aldrovandus and other authors of high standing from the days of the Ancient Greeks onwards.



Mary Evans

Poison investigated

Tarantulas are found in different habitats according to the species, from lowlands to mountains up to and above 2 000 ft, on open country such as moors, heaths and grassland, and also in woodlands. They live in short burrows in the ground and spin no web but, like wolves, run down their prey which is mainly small insects. They kill these by injecting a poison. Henri Fabre, the famous French entomologist, found this was instantly fatal to insects, but he went further to investigate the potency of the poison in relation to the legend. He found the tarantula would bite a sparrow but that a young sparrow took 3 days to die, and a mole died in 36 hours. From this he concluded that the bite could be troublesome to people and that measures to counteract the poison should be taken.

Male tarantula dances

As in all spiders the courtship is elaborate, and, fittingly, in these species the male does a dance. WS Bristowe, in his *Comity of*

The Tarantella.

So far as we can see, these strange evolutions eventually bring the female into a mood to mate, and it is not without profit to recall that the human victim of the tarantula's bite, dancing to cure himself, infected those who watched. In his case, however, he produced a kind of mass hysteria, which has been called tarantism.

The female, like other wolf spiders, carries her eggs in a silken cocoon attached to the tip of her abdomen. When the 40 or so spiderlings hatch they ride in a crowd on the back of the mother's abdomen.

Disease and remedy

The bite of the tarantula was supposed to bring on a general melancholy which in the end proved fatal. The only thing for the victim to do was to call for one or more musicians who, with their pipes and fiddles, would play a succession of tunes until they

△ *Tarantella*: legend has it that in Taranto, a town in southern Italy from which the spider's name is derived, the poisonous bite was cured by making the victim perform a frenzied dance called the tarantella.

▷ *Tarantula*: the spider that started all the fuss. *Lycosa tarantula*, poised menacingly above its burrow. Its long, hairy legs and body and beady stare make it easy to see why many people find it so repulsive.

phylum	Arthropoda
class	Arachnida
order	Araneae
family	Lycosidae
genus	<i>Lycosa barbipes</i>
& species	<i>L. cuneata</i> <i>L. pulverulenta</i> others



Tarpon

The tarpon is a marine and freshwater fish renowned for its violent reaction to being hooked and for the sport it gives the big-game sea angler. Scientifically it is important as being one of the most primitive of the true bony fishes, or teleosts.

The primitive characters include having only one dorsal fin and one anal fin, a symmetrical forked tail fin, pectoral fins set low on the shoulders, pelvics set well back and the body covered with cycloid scales (scales with no 'teeth' on the free edge). In addition all the fins lack spines, the fin rays supporting them are soft and jointed, and internally there is a swim-bladder which opens by a duct to the gullet.

The tarpon can be recognized by the long filament extending backwards from the rear of the dorsal fin and by its large silvery scales, which in a large individual may be

as well as showing they can acclimatise to low temperatures it suggests they may sometimes make long migrations. From the results of tagging, however, it seems that most tarpon do not move more than about 20 miles from 'home', possibly making no more than short migrations to deeper water in winter and back to shallow waters in spring. On the whole, the information we have up to now suggests that, as in the North Sea herring, a successive movement into shallow water from south to north gives an impression of a mass migration. In this, the first tarpon move inshore in spring in the south, the next wave comes in a little later farther north and so on.

Tarpon must come to the surface to gulp air despite their having well-developed gills. They are said to surface with a characteristic rolling movement and then go down again. Traditionally, the direction of the dorsal filament dictates the direction of roll. This need for gulping air begins early in larval life and young tarpon easily drown if prevented from surfacing.

juvenile tarpon lives in stagnant brackish waters in almost landlocked estuary pools.

The air-gulping habit of the tarpon enables the young ones to live in waters poor in oxygen. Theoretically this should make them safe from most enemies of small fish, yet we know they are eaten by kingfishers and herons, pelicans and alligators. Out at sea, when the tarpon are larger, they are snapped up by porpoises and dolphins as well as large sharks. There is probably a fair degree of cannibalism also.

First sports fish

It has been said that it was the tarpon that led the way to what is now a widespread sport, especially off Florida: sea angling or game fishing. In the early 1880's it was thought impossible to land a fish of more than 100 lb on a rod and reel. In 1884 Samuel H Jones of Philadelphia landed, after a struggle, a tarpon 7 ft 4 in. long weighing 172½ lb. Another angler, still anonymous, offered 'a free railroad ticket to



Russ Kinne: Photo Res

2 in. across. Three of its many common names are big scale, silver fish and silver king, as except for a darkening on the back it is silvery. Tarpon are up to 8 ft long and can weigh up to 340 lb.

They occur in coastal waters along the tropical and subtropical Atlantic coast of America and tropical West Africa. A related but smaller species, the ox-eye, lives in the Indo-Pacific.

Deceptive migrations

Adult tarpon are mainly solitary. They are remarkable for being able to live equally well in salt water and fresh, often being seen well up the rivers, and young tarpon will survive direct transfer from one to the other. Tarpon are sensitive to sudden cold and are killed by cold currents of less than 17°C/64°F entering their area. They will however, survive temperatures as low as 12°C/55°F if the change is gradual. For example, tarpon are sometimes encountered as far north as Nova Scotia, and

They even eat each other

Young tarpon feed on animal plankton, mainly the water flea *Cyclops*, until 3½ in. long. One tarpon had 4 000 of these small crustaceans in its stomach. Later they begin to take crab larvae and aquatic insects and then pass to an almost wholly fish diet, chiefly of mullet, bream and needlefish, with crabs, and sometimes a smaller tarpon.

Breeding mysteries

For many years it was a mystery where and how tarpon bred. Even now it is possible to fill in only a few of the details. Spawning seems to be from late June to September, in the shallow seas. A 4ft female may lay up to 12 million pelagic eggs. The larvae hatching from the eggs are small, ribbon-shaped, leptocephali (see eel p 824), colourless and transparent, ½ in. long. The smallest of these have been found well over 100 miles out to sea, carried out by currents. As they develop they are carried back to the shore by high tides and winds, where they metamorphose into young tarpon. At a later stage the

△ Ships that pass: mighty tarpon at rest, timid triggerfish at speed in the opposite direction.

Florida and three months' room and board at a hotel' for anyone catching a tarpon of this size. The reward was, apparently, never claimed but it was not long before other anglers were making their way to Florida to catch tarpon, break records, and also catch marlin, tuna and swordfish. Nearly 70 years later so little was known of the biology of this popular sports fish that in 1955 Mr Roger S Firestone inaugurated a fund for supporting tarpon research, and even today our knowledge of this big fish amounts to little more than the bare details given on this page.

class	Osteichthyes
order	Elopiformes
family	Megalopidae
genus	<i>Tarpon atlanticus tarpon</i>
& species	<i>Megalops cyprinoides ox-eye</i>



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