THE new FUNK & WAGNALLS ILLUSTRATED WILDLIFE ENCYCLOPEDIA

VOLUME 17

PIK-PUR

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BOOK NO.
622

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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
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The Dun & Bradstreet Corporation

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Cover Photo: Barn Owl
Hans Reinhard—Bruce Coleman Ltd.

Frontispiece: Atlantic Puffin
Eric Hosking

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

Printed in the United States of America

Volume 17

Pika

Pikas are small mammals related to the rabbits and hares. They are known by a variety of names, including mouse-hares, rock rabbits, rock conies, calling hares, piping hares and whistling hares. There are two species in North America and 12 in Asia; the largest is a foot long, the smallest less than half this. They look like rabbits or hares with short rounded ears, tailless and with the four legs more or less the same length. Each foot has five toes, and the soles of the feet are hairy, enabling them to run easily over smooth rock surfaces. The fur of pikas is usually greyish brown above and lighter on the underparts, but is reddish in one species. In general the coat is lighter coloured in dry areas, darker in more humid regions. Some species have two moults a year giving a summer coat that is reddish or yellowish and a grey winter coat.

The North American pikas live in and around the Rockies, in the Sierra Nevada, Utah and New Mexico and southeastern Alaska and the Yukon in the north. In Asia they range from the Volga and Urals to Korea and the Japanese island of Hokkaido, and in southern Asia from Iran to Nepal.

From lowlands to Mount Everest

One species of pika lives on Mount Everest up to 17 500 ft, the highest altitude at which any mammal has been found. Pikas live in a variety of habitats; on plains, in deserts, in forests and on rocky mountainsides. One of their most noticeable features is their voice which is usually a whistle or a sharp bark, ca-ak, repeated many times. Both calls are remarkably ventriloquial, the body being jerked forwards and upwards at each cry. Pikas rely for safety on remaining hidden, dropping into a crevice and there lying still. Among rocky screes they use the crevices and cavities as shelters, while on the plains they burrow.

Making hay while the sun shines

Pikas usually live in places where the winters are cold but they do not hibernate. Instead they have the remarkable habit of cutting vegetation with their chisel-like teeth, drying it in the sun and storing it for winter fodder. A pika may travel several hundred feet from home to cut herbs and grass, carrying these in its mouth to a chosen spot to dry, adding a fresh layer each day. Some climb into the lower branches of young trees to take young green shoots. In winter bark is sometimes eaten as the pikas tunnel under snow, but the main food even then is the dry fodder. This is stored under an overhanging shelf of rock or under a fallen tree, a single store holding a bushel of hay. Pikas feed in the early morning and late afternoon. Midday is spent basking. During the day the droppings are small, green and dry. At night they are black and wrapped in a jelly-like layer which keeps them soft and wet. These are swallowed again and kept in the stomach to be mixed with fresh food and redigested, a habit first noticed in rabbits. It has been found that if rabbits are prevented from eating their soft night droppings they will die in about 3 weeks as the droppings are their only source of certain essential vitamins, formed by the activity of bacteria breaking down partly digested plant material in the droppings.

The miners of the Yukon and elsewhere in the western half of North America called the pika the starved rat. Although strictly vegetarian they must, nevertheless, be well fed and far from deserving this nickname. Animals in the north temperate regions can stand up to cold so long as they are well fed. It is not the hard winters that kill but food shortages due to freezing up. Pikas keep going even when the ground is covered with snow, because they have their food stores. They even sun themselves on rocks in temperatures of −17°C/0°F!

Small naked babies

The breeding season is May–September, when each female may have 2 or 3 litters. The gestation period is 30 days and there are 3–5 babies in a litter. Each is born naked and helpless and is put in a nest of dried grass. They weigh 1 oz at birth against the 1 lb weight of the adults, but reach full size in 6–7 weeks, having been weaned

*Summing up the situation. An Asiatic pika **Ochotona hyperborea** with its small rounded ears flattened back, hesitatingly emerges from its hiding place among the rock crevices. Its main hope of safety lies in remaining hidden from the weasels, small carnivores and hawks that prey on it.*

when about a quarter grown. The life span of the pika is 1–3 years and during that time their enemies are weasels and other small carnivores, and hawks.

A modern guinea pig?

Pikas enjoyed a measure of obscurity for a long time, but they now look like emerging to fame as laboratory animals. They were first discovered in North America in about 1828, and the naturalist Thomas Nuttal has left us a record of how he heard, in the Rockies, 'a slender but very distinct bleat, like that of a young kid or goat. But in vain I tried to discover any large animal around me'. Finally he located the little animal 'nothing much larger than a mouse'. Pallas discovered the first pika in Asia in 1769 and although he, and others after him, found species after species in the mountainous parts of Asia and on the steppes, little more was known of them except what they looked like, together with their habit of storing hay and their ventriloquial voice, until about a quarter of a century ago. Since then scientists in the USSR have been paying a lot of attention to them. This is not because they are a nuisance, for they live in out-of-the-way places where they do not clash with man's interests, but because they have all the advantages of the guinea pig as a laboratory animal: they are easy to feed and maintain, inoffensive, and they do not need much room.

class	**Mammalia**
order	**Lagomorpha**
family	**Ochotonidae**
genus & species	***Ochotona pallasi*** *Pallas' pika* ***O. princeps*** *Rocky Mountain pika* ***O. wollastoni*** *Mount Everest pika* *others*

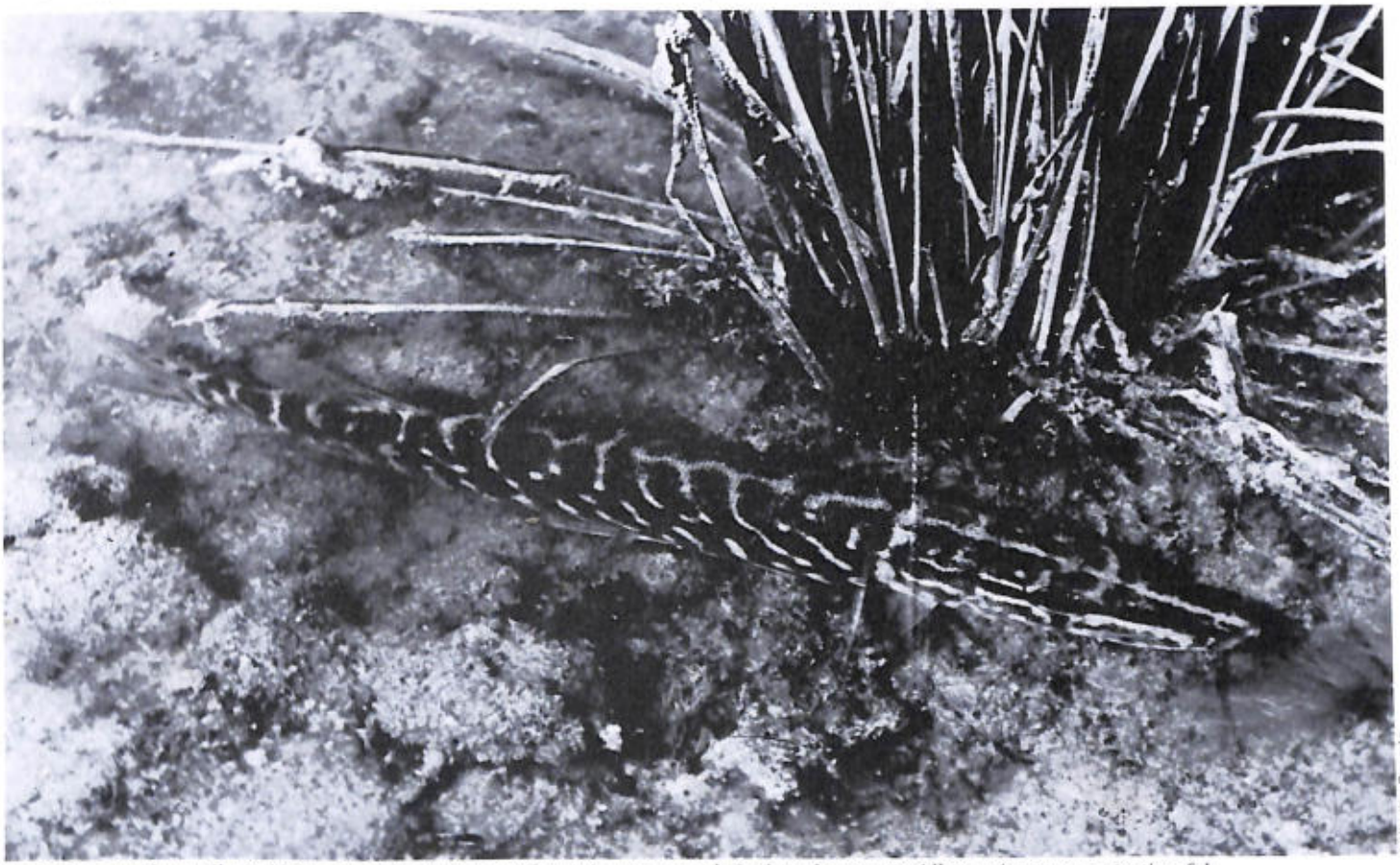
P Morris

△ *One of the many Russian pikas* ***Ochotona pusilla*** *— a compact, tailless bundle of fur.* ▽ *An all weather animal:* ***Ochotona collaris*** *in its winter coat.*

Chas J Ott: Photo Res

Pike

The pike, aptly nicknamed the 'freshwater shark', is the fiercest predatory fish in the fresh waters of the northern hemisphere. It and its relatives, the pickerel and muskellunge of North America, are held in awe by some fishermen, contempt by others; to many they present a challenge, backed by the legends of size and ferocity—often very tall stories. The record of the largest pike caught is of a 53lb specimen.



A Nieste: Bavaria

Ambush: a northern pike in hiding. It will wait here until prey is near enough for it to dart out rapidly to seize an unsuspecting fish.

The pike—or northern pike, as it is known in North America—is long bodied with a large flat, almost shovel-shaped head with large jaws and large mouth bristling with teeth. Its dorsal and anal fins are set far back. Its colour ranges from olive to dark green with pale yellow spots. It grows up to 4½ ft long and weighs up to 53 lb. The muskellunge of the Great Lakes is very like the pike but has scales on only the upper part of the cheek instead of all over it. It grows to 8 ft long and can weigh up to 110 lb. The grass pickerel, from Nova Scotia to Texas, grows up to 2 ft long, and has dark bands on the flanks. The smaller chain pickerel of the eastern United States grows up to 14 in. long and has a chain-like network of dark markings on the side. The black-spotted pike, which is sometimes called the black-spotted pickerel, lives in eastern Siberia, and very little seems to be known about this fifth member of the family.

Ambush

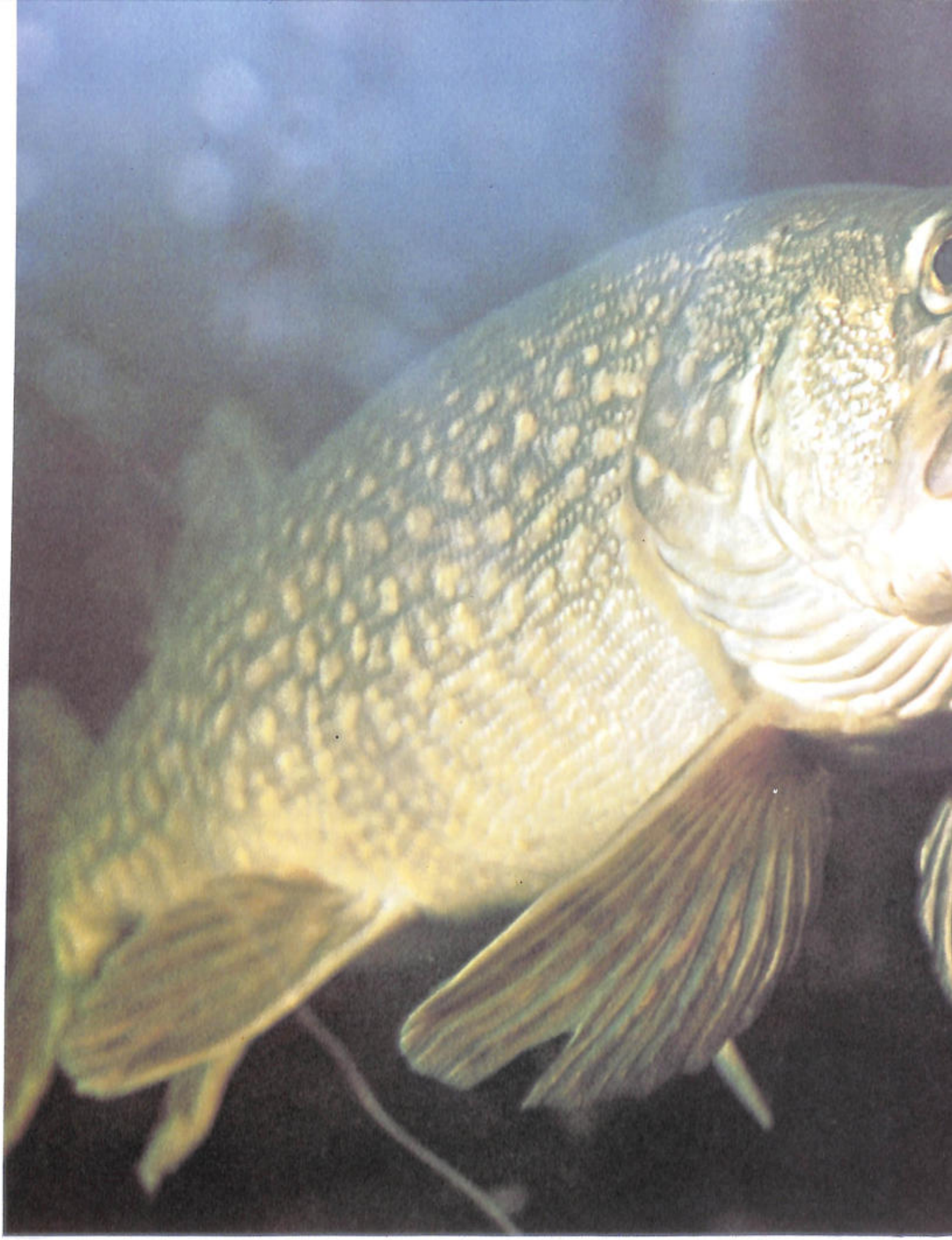
Pike live in still and running water, spending most of their time motionless among water plants with which their colours harmonize. The pike usually stay in one place and dart out to ambush their prey. Having the dorsal and anal fins set far back on the body gives great thrust to the tail and rapid acceleration, sending the pike out 20–30 ft to seize prey. A pike detects its prey by sight rather than by smell, at distances of up to 50 ft by day, but is probably warned of its approach by vibrations in the water, for a blind pike can also catch food. A pike can see at night as well as by day. Its habit is to lie well down in the water because its eyes are set in the top of the head and look mainly forwards and upwards. It has two sighting grooves running to the tip of the snout. A pike's brain is relatively very small, $\frac{1}{168}$ of the total body weight, much of this being taken up by the optic lobes. This reflects the little effort the pike needs to make a living.

Gin trap jaws

When very small, pike feed on water fleas, worms and the fry of other fishes. As they grow they take progressively larger fish and are less and less tempted by small prey unless it comes so close they can snap it up without moving. They are almost exclusively fish-eaters, especially of fishes belonging to the carp family Cyprinidae and trout. Large pike will also take other water dwellers such as ducks, moorhens, coots, water voles and frogs. There are many authenticated reports of pike eating prey their own size. This is possible no matter how much it struggles because of the pike's teeth. Those on the sides of the lower jaw are strong and stick straight up. They are used for seizing prey. The teeth of the upper jaw are smaller, most numerous in the front, and are curved backwards. The roof of the mouth is bristling with teeth pointing backwards, and these prevent prey slipping out of the mouth. The mouth itself has a wide gape. Sometimes large prey may become jammed in the pike's throat with fatal results for the pike, which cannot get rid of it because of the backwardly directed teeth. Large prey successfully swallowed takes a long time to digest, and after a big meal the pike lies inert for a week or more, often near the bottom, taking no notice of prey or the fisherman's bait. A pike can take in large prey because its intestine is more or less straight, its stomach being merely a dilatation of the front part of it.

Unusual digestive juices?

A hungry pike will seize prey of a certain size depending on its own size and usually providing its quarry does not move too slowly, although an angler will catch a pike using stationary dead bait. Pike learn, however, not to go after sticklebacks once they have had experience of their spines. It is sometimes said that the digestive juices of a pike 'are phenomenal', because even hooks are eaten away by its stomach acids. This is, in fact, illusory. When digesting a fish the pike's acidity is high on the surface of the prey, very low inside it, and a pike takes 3–5 days to digest a moderately sized fish. A similar high acidity on the surface of a hook would soon erode it.



Barry Pengilley

High egg wastage

Pike spawn from February to May, the younger individuals spawning first. They are stimulated to spawn by the increasing day length and light intensity. They assemble in shallow water, each female attended by several males. Estimates of the number of eggs laid by each female vary from 40 000 to 500 000, the number depending probably on the size of the female. Many fail to be fertilised because the micropyle, the hole in the egg membrane through which the sperms enter, closes 30–60 seconds after they are laid. At first the eggs are sticky and lie singly on the bottom, later rising just off the bottom. They hatch after 2–3 weeks, the larvae feeding on the remains of the yolk sac for 10 days, before starting to catch their own food. The parents take no care of their eggs or young.

Automatic control of numbers

As pike are at the apex of a food pyramid they probably have few enemies except when very young. There is, however, considerable cannibalism which keeps a proper balance. The more richly a water is stocked with other fish the less the cannibalism; and the end result is that pike are seldom so numerous as to deplete the waters, in which they live, of other fish.

Methuselah pike

Most pike live about 7 years once they have survived the massacre of infancy but they have been known to live 10 years or more and Dr C Tate Regan once asserted that possibly 'fish of sixty or seventy pounds weight are at least as many years old'. There have, however, been many exaggerated claims, like the one, first told by Gesner in 1558, about the famous Emperor's Pike. This pike was supposed to have been caught in a lake in Württemburg in 1497 with a copper ring round its gill region with an inscription saying it had been placed in the lake by the Emperor Frederick II in 1230. So it would have been more than 260 years old. What was not explained was why the ring fitted it so well as pike continue to grow until they die. Had it been put on 260 years before the ring would surely have been a tight fit by 1497.

The pike was said to have been 19 ft long and to weigh 550 lb, and there was a painting of it in the castle of Lautern in Swabia. What appears to be a copy of this still hangs in the British Museum (Natural History). Its skeleton is said to have been preserved in the cathedral in Mannheim. When scientists studied it in the 19th century it was found to have too many vertebrae in its backbone!

class	**Osteichthyes**
order	**Salmoniformes**
family	**Esocidae**
genus & species	***Esox americanus*** *grass pickerel* ***E. lucius*** *northern pike* ***E. masquinongy*** *muskellunge* ***E. niger*** *chain pickerel* ***E. reicherti*** *black spotted pike*

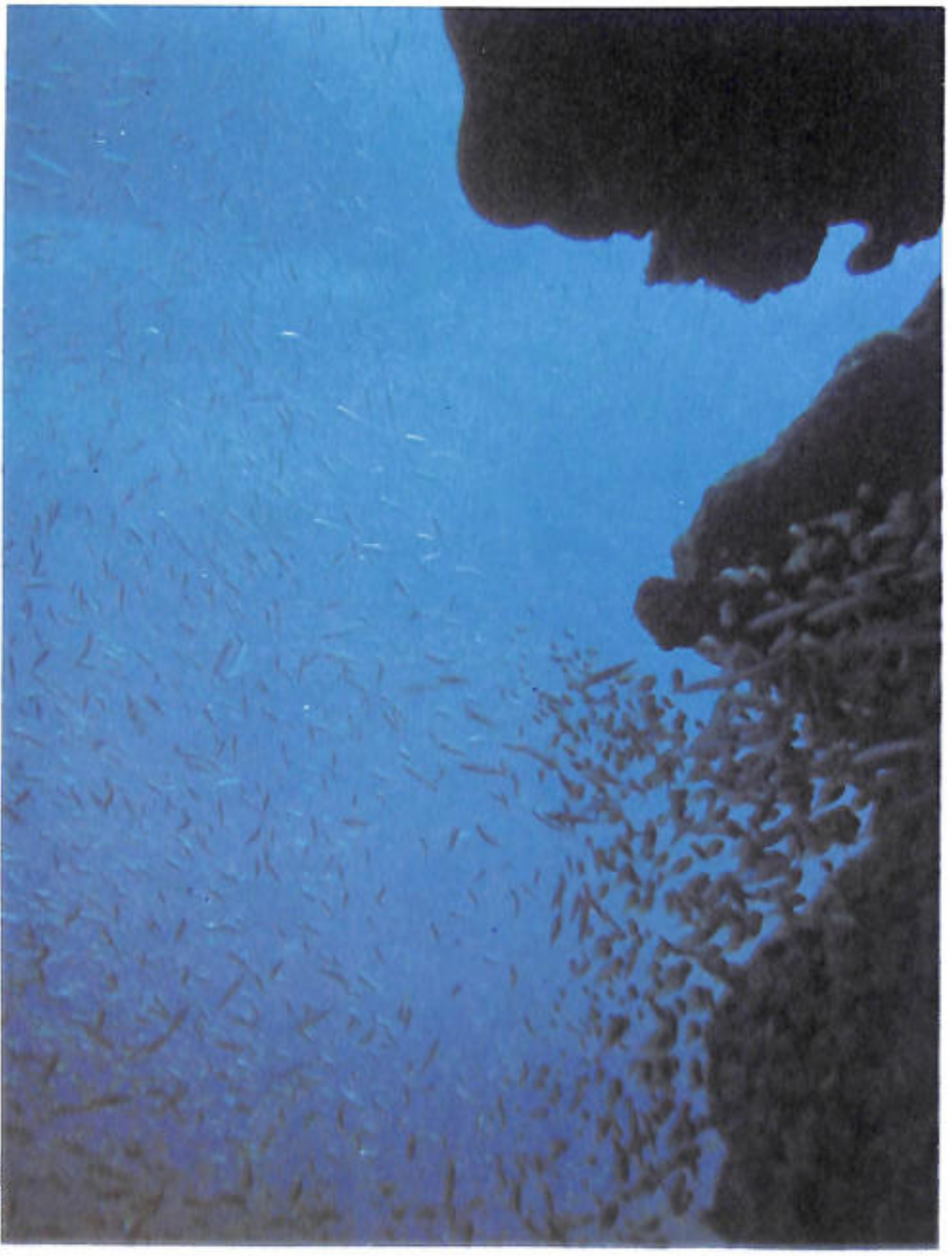
◁ *Gin trap jaws: a pike can eat prey its own size with the help of its well appointed dental set.*

Pilchard

Like its relative, the herring, the species, ***Sardina pilchardus,*** *is highly exploited by man—as a sardine when young and a pilchard when adult. The young fish support an extensive canning industry in France, Spain and Portugal; the adults are best known for the pilchard fishery which formerly flourished off Cornwall. The commercial division into sardine and pilchard arises from the geographical races of the species and the extensive migrations.*

An adult pilchard is a silvery fish, shaped like a herring but a little smaller and slightly fatter, growing up to 10 in. long. Its dorsal fin is slightly forward of the midline of the body instead of more or less at the centre, as in the herring (p. 1196). Its scales, also, are larger than those of a herring. Otherwise the two are very alike. As in the herring the scales are deciduous. That is they lie in shallow pockets on the surface and are easily rubbed off.

The pilchard is divided into northern, southern, Moroccan and Mauretanian races. The first may go into the North Sea, as far north as Northumberland, although it rarely goes farther east than Plymouth, in the English Channel. Southwards it ranges to the Cantabrian coast of Spain. The second ranges from Cantabria to Cadiz, the third from Morocco to Rio de Oro on the bulge of Africa, and the fourth, a dwarf race, from Rio de Oro to Dakar in West Africa. There is a Mediterranean subspecies ***S. pilchardus sardina.*** *The closely related genus* ***Sardinops*** *has two species with several subspecies:* ***S. sagax sagax*** *lives off the coasts of Chile and Peru,* ***S. sagax melanosticta*** *off Japan,* ***S. sagax ocellatus*** *off South Africa, and* ***S. sagax neopilchardus*** *off the southern half of Australia and around New Zealand. A second species* ***Sardinops caerulea*** *lives off the Pacific coast of the United States.*



Ben Cropp

◁ *Thousands of pilchards schooling on the Barrier Reef bring order out of confusion as they gather in a clockwise direction into a school. The fish will arrange themselves in echelon and each school consists of fish of approximately the same size.*

Tinned shoals

Pilchards live in enormous shoals with the individual fishes arranged in echelon. The shoals are made up of fishes of approximately the same size—that is, in age groups—which is a great convenience to man because they sort themselves out naturally for canning! The shoals swim at differing depths during the day and night since they tend to follow the vertical migrations of plankton. By means of very fine gill-rakers the fish sieve even small diatoms from the water passing into the mouth and throat and out by the gills and pick off large numbers of copepods and other planktonic crustaceans. In summer these form the bulk of their food. There is a good deal of variation in the weight of the fish compared with its length, due to the amount of fat in its body. Pilchard feed most from April to July and again in October, when they are heaviest. From November to February or March they fast, taking at most only a very little food.

Drift-netting

Vast shoals are bound to be preyed upon by many predatory fish and seabirds, but the greatest predator is man. The sardines react to attacks from fish and birds by swimming together and milling around in large tight and compact balls, a defence that would be useless against the drift-nets and seines used by fishermen. For pilchards, for example, the nets are shot at sunset, fastened end to end, with one end attached by a rope to the bows of a boat, nets and boat then drifting with the tide.

Identification by balance

Shakespeare seems to have believed that 'Fools are as like Husbands, as Pilchers (pilchards) are to Herrings'. The standard way of discriminating between a herring, pilchard and sprat is to hold each by its dorsal fin. The herring hangs horizontally because the fin is at the centre of the back. In the pilchard it is nearer the head, so the tail dips, and in the sprat it is nearer the tail, so its nose drops. In fact, herring and pilchard are so alike there has even been talk of their hybridizing, and fishes are caught that look very like hybrids. They have 30 rows of scales along one side of the body and 50 along the other. The explanation is that pilchards have oblique rows of alternately large and small scales. In a normal pilchard the small scales are hidden by the large ones. In the hybrid the scales of one side are all large, while those on the other side are large and small.

class	**Osteichthyes**
order	**Clupeiformes**
family	**Clupeidae**
genus & species	***Sardina pilchardus***

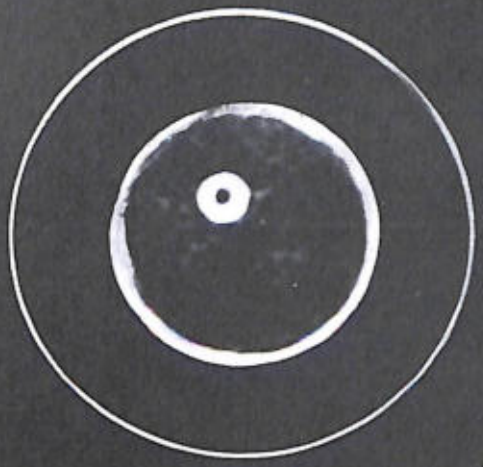
Preferred spawning temperatures

The spawning is from April to July when each female lays up to 60 000 large eggs, 20–40 miles from shore, in waters with a temperature of 10–17°C/50–63°F. The eggs are peculiar in having a large space between the egg itself and the outer membrane. This, with the large globule of oil each contains, makes the eggs buoyant and they float at the surface. The larvae hatch in 3 days or so, each being $\frac{1}{4}$ in. long.

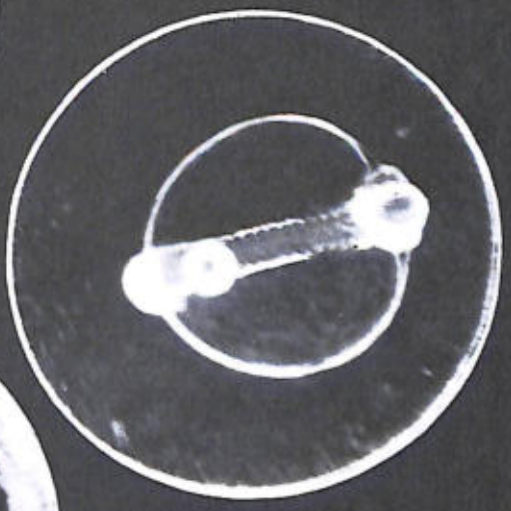
The temperature needed for spawning differs for each race of pilchard but lies between the limits already quoted. In the northern race there are two distinct populations. One spawns south of Cornwall, sometimes in the English Channel as far east as Dover, or off the coast of Brittany, the young fishes then migrating south to the level of St Jean-de-Luz where they stay for 2 years before migrating northwards to spawn on the grounds where they were hatched. They are fished as sardines off the west coast of France and the north coast of Spain, and as pilchards off Cornwall. The second population spawns in the Bay of Biscay, the young fish from these eggs spending their first 2 years in the same place, after which they migrate north as mature fish (pilchards) and do not return to their birthplace.

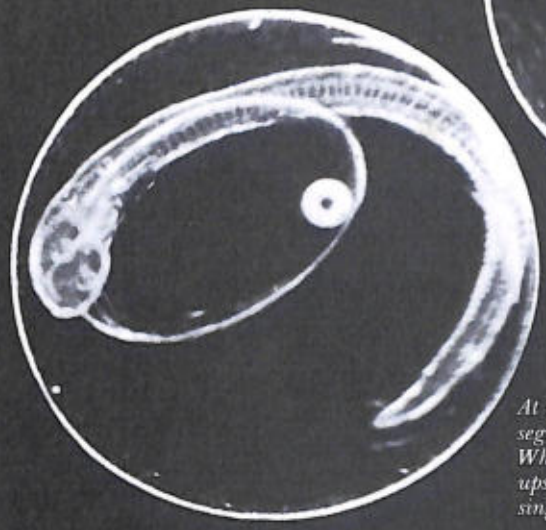
In the southern race the young fish, 2 years of age or less, are found off Portugal, the 2–6 year olds being found off the north coast of Spain. In the Moroccan race the young are found off Agadir and the adults off Safi.

Spawning and post-spawning migrations take place from November to June from Gibraltar to Galicia, from November to April from Santander in Spain to Areachon in France, from February to July off Brittany and from April to November in the Celtic Sea—the area west and southwest of Cornwall. The appearance from south to north of shoals of adults following the successive spawning periods gave rise to the idea that there was an extensive south-north migration, whereas it is only a succession of small migrations of local populations.

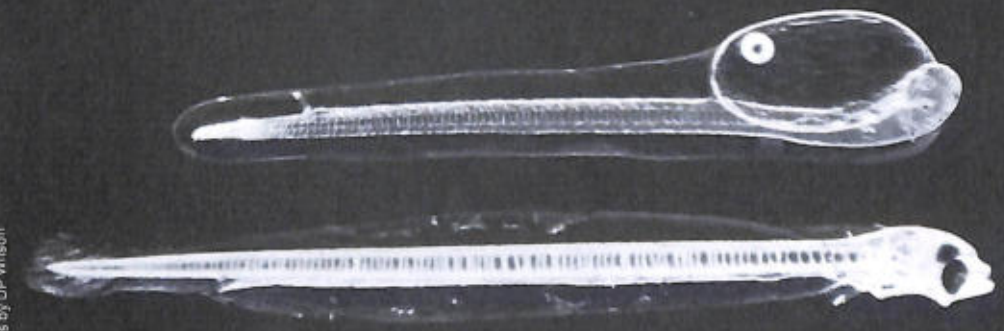


From egg to fish—the fertilised egg and oil globule are enclosed in a delicate capsule. Part of the egg develops into the embryo, the remainder into the yolk sac which serves as a food store for the developing embryo (× 40).



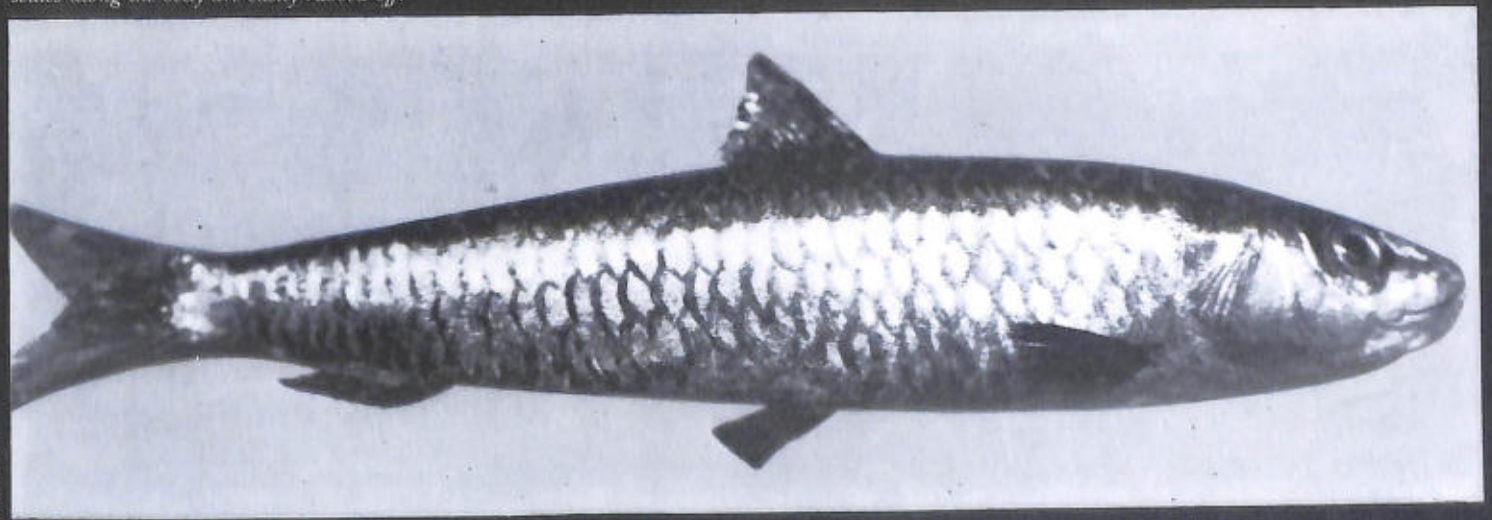


At a later stage the embryo shows clearly the segmented body muscles, head and tail regions. When it hatches out the larval pilchard floats upside-down in the plankton because of the single oil globule in the yolk sac (× 30).

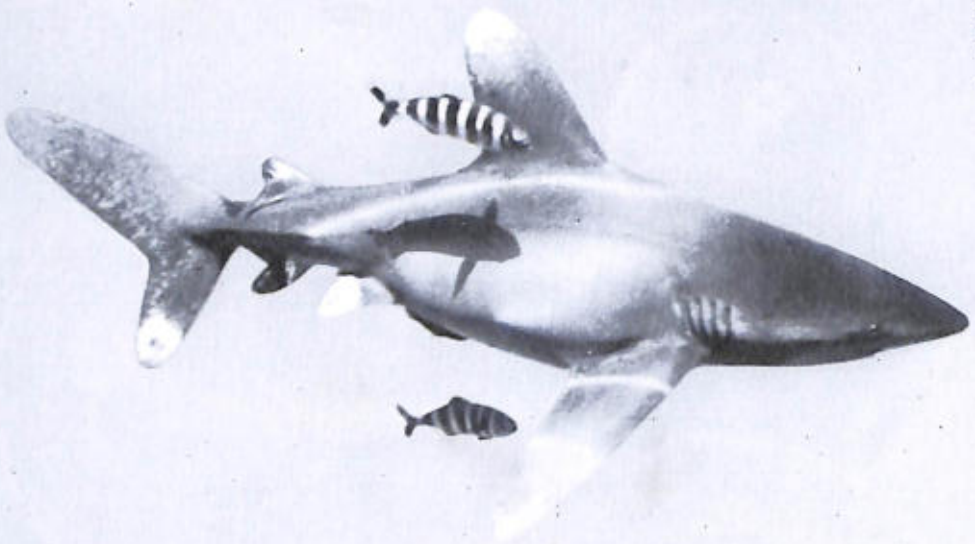


Series by DP Wilson

▽ *The unassuming pilchard is an important source of food especially in Spain and Portugal. Like the herring it has soft-rayed fins, and the scales along the belly are easily rubbed off.*



Poppertoto



Ludwig Siliner

Shark's jackal? Pilot fishes swim alongside a whitetip shark ***Carcharhinus longimanus****. It was believed that pilot fishes guided sharks and rays towards suitable prey, receiving in return protection from enemies because of their closeness to a formidable companion. In reality, however, both fishes are in search of food, the pilot no doubt benefiting from the efforts of its big companion but never leading the foray.*

Pilot fish

The pilot fish is so named because it was believed to guide sharks and whales, and to lead ships or solitary swimmers to land or to a port when they had lost their way. These beliefs go back at least to the time of the Ancient Greeks.

The pilot fish can grow up to 2 ft long. It has a strongly forked tail that is blackish with white tips, a prominent dorsal fin with 4 strong spines in front of it, a prominent anal fin and small pectoral and pelvic fins. Its body is marked with 5–7 dark bands, brownish to black, on a background of white to bluish-white. It is widespread through tropical and temperate seas and is occasionally caught off the coasts of the British Isles.

Social hangers-on

So far as one can tell, pilot fish do nothing else than swim about in company with large sharks, whales, giant mantas, large schools of tunny and sailing ships. They have sometimes been caught in mackerel and herring nets. Although the ancient belief is that they lead, and therefore guide or act as pilots, they more commonly swim at the side or even follow other fish. Nevertheless, the association is a very persistent one. Pilot fishes accompanying a shark which is then hooked and hauled on board ship have swum around its tail, the last part of the shark to leave the water, as if distracted. Again, a pilot fish is recorded as following a sailing ship continuously for 80 days. The idea that they piloted a ship to port was fostered to some extent by the way the fish left it as it neared land or after it had entered harbour. One explanation for this, which does not seem unreasonable, is that they turn away when they feel the freshwater brought down by rivers.

Why pilot fishes should accompany large animals and other objects is something of a mystery. One explanation put forward is that, with their better eyesight, they see food before the shark does and lead it to it, taking the scraps as the shark feeds. This is, however, almost entirely guesswork dating at least from the 16th century when pilot fishes were called the sharks' jackals. What seems more certain is that a pilot fish may suddenly dart from a shark's side to snap up something, but it quickly returns to take up station once more. On the few occasions that pilot fishes have been caught and their stomachs examined they seem to have been eating small fishes rather than scraps of food.

Different babies

Spawning seems to take place in the early summer well away from land. It is always said that the eggs float at or near the surface but a note from the Soviet scientist AI Svetovidov, published in 1958, says that pilot fishes always lay their eggs on the skin of sharks or the submerged hulls of ships. The parents then stay with the eggs until they hatch. The larvae hatching from them are so unlike the parent that they were originally thought to belong to a separate species. They have large eyes and numerous spines on the head, and they shelter under the bells of jellyfishes and among the tentacles of the Portuguese man-o'-war, under bunches of Sargasso weed and pieces of floating wreckage.

Fatal shelter

So little is known for certain about the way of life of pilot fishes, and what is known seems extraordinary. It is always supposed that by swimming under the bells of jellyfishes or among the tentacles the baby pilot fishes are protected from enemies. This may be true but they are also exposed to the dangers of being eaten by animals which feed on jellyfishes. These are more numerous than one would think. They include seabirds, such as frigate birds and fulmars and the large fishes, including the large ocean sunfishes. Indeed, there must be the suspicion that these animals may be taking the jellyfishes more for the fishes sheltering under them since jellyfishes are 99% water.

Why follow sharks?

There is also uncertainty about the protection a pilot fish gets from swimming near a shark. It is usually taken for granted that it does get protection because the shark itself is so voracious that potential enemies are unlikely to come near, but a pilot fish would get no protection from swimming with a whale or a shoal of tunny, less still from a bunch of Sargasso weed, a piece of floating wreckage or a sailing ship. We know that pilot fishes sometimes travel inside the mouths of large rays which do not eat fish. It may be they sometimes enter the mouths of sharks—but do not live to serve as evidence! All the signs are that pilot fishes have the instinct to swim near a body larger than themselves; when young it is a jellyfish, when adult it is anything from a shark to a schooner. The very early idea that they are friendly to man is not far from the truth if by being friendly we mean they like to keep close to us—or to our ships.

The researches of the Soviet scientist VV Shuleikin, published about 1957, give the only valid reason for pilot fishes swimming beside sharks and ships. Shuleikin calculated that sharks swim three times as fast as a pilot fish possibly can. How then does a pilot fish keep up? Over the surface of any body moving through water there is a 'boundary layer' of water moving forward at almost the same speed as that of the body. This is thickest over the tail half of a shark, which is where a pilot fish usually swims. So presumably the pilot fish is able to travel hundreds of miles in a boundary layer carried along by it, with a minimum of effort.

class	**Osteichthyes**
order	**Perciformes**
family	**Carangidae**
genus & species	***Naucrates ductor***

Heather Angel

Pilot whale

Also called the blackfish or caa'ing whale, the pilot whale is a dolphin that can grow to 28 ft long. Its most distinctive feature, from which it gets its scientific name of ***Globicephala****, is the bulging forehead, which forms a dome overhanging the mouth. The upward curve of the mouth gives it an amused look. The tapered flippers are long, about ⅕ of the total body length. The dorsal fin stands about 1 ft high. Pilot whales are black except for a white patch under the chin.*

Pilot whales are found in many parts of the world but are absent from the polar seas. ***Globicephala melaena*** *of the North Atlantic and Mediterranean ranges as far north as Greenland. It is common off the Faeroes, Shetland and Orkney.* ***G. macrorhyncha*** *is found in the Caribbean and off the southeast seaboard of the United States.* ***G. scammoni*** *lives in the Pacific Ocean. The last two species have shorter fins than* ***G. melaena****.*

Mass suicide

Pilot whales live in large schools sometimes numbering hundreds, or even thousands. Each school is made up of both males and females and it has often been reported that a male acts as a leader. This is presumably how these animals got their name, but it is more likely that there is a general tendency to follow any individual. Hunters have found that when one pilot whale is wounded and rushes away, the other members of the school follow it. A dolphin named Pelorus Jack, that regularly followed ships plying between Wellington and Nelson, New Zealand, for 20 years, may have been a pilot whale exhibiting its following habit. On the other hand, some writers think that Pelorus Jack, who had the distinction of worldwide fame and protection under Order in Council, was a Risso's dolphin *Grampus griseus*. The habit of following a leader has, however, made schools of pilot whales very susceptible to become stranded. If one whale, perhaps becoming panic-stricken at finding itself in shallow water, goes ashore, the others follow like sheep. Attempts have sometimes been made to refloat stranded pilot whales, but they have failed. As soon as one whale is dragged into deeper water, it swims back to the shore. Presumably the rescued whales are blindly answering the calls of the stranded ones. Killer whales behave in the same way.

John Tashjian at Marineland of the Pacific

△ *Letting off steam? A Pacific pilot whale* ***Globicephala scammoni*** *surfaces, 'blowing its nose' as it breathes out. The whale's spout is not water. Whales can submerge for more than half an hour and can tolerate an increase of carbon-dioxide in the blood during this time. Previous page: Follow-the-leader; a school of pilot whales, identified by high dorsal fins.*

Blind hunting

Pilot whales are armed with 7–11 teeth in each side of each jaw. These are used for grabbing slippery prey, which is mainly squid and cuttlefish, but fish are also taken. The eyesight of pilot whales is not good and their bulbous heads and inflexible necks must prevent them from seeing objects directly ahead, so perhaps they use sound waves to find food like other dolphins.

Warm water breeding

Sightings of pilot whale schools over many years show that they migrate regularly. The migrations are partly regulated by food supply, as when pilot whales move to the coast of Newfoundland in summer after the squid *Illex*, but there is a more general movement to warmer waters in winter. It appears that mating takes place in the warmer waters and calves are born when the pilot whales return to cooler regions in the following year.

It is usual for whales to migrate to warmer seas to breed, as does the blue whale (p 384) for instance, for newborn whales have very little insulating blubber. To compensate for this the whale's milk is extremely rich, having only 40–50% water, half as much as cow's milk. The fat content of whale's milk is very high 40–50%, that of cows is only about 4%.

Until observations were made in oceanaria, very little was known about the mating habits of whales, but pilot whales had been seen courting in the wild. The partners have been seen stroking each other with their flippers or bodies as they swim slowly past and on one occasion the mate of a weather ship watched the amorous antics of about 20 pilot whales. They were swimming side by side in pairs, playfully biting each other's mouths, and surfacing vertically until their flippers were exposed. They would then submerge and lie belly to belly for about 20 seconds, copulation in whales being extremely rapid.

Female pilot whales start to breed when 6 years old and bear young in alternate years. They are barren at 18 years. Males mature in 13 years. Pilot whales are thought to live for a maximum of about 50 years.

Orgy of slaughter

For hundreds of years pilot whales have been hunted in the islands to the north of the British Isles. The hunts, which are still carried on in the Faeroes, but have ceased in Orkney and Shetland, depend on a school of pilot whales being sighted near the shore. The alarm is given and a fleet of small boats puts out to carefully shepherd the school into a bay. The whales panic and rush into the shallows. Men from the boats and those waiting on the shore immediately set on the whales with knives and lances.

When the slaughter is over the carcases are stripped of their blubber. The division of the spoils follows a strict tradition. Certain proportions are awarded to the man who first spotted the whales, those who went out in the boats, the men who helped in the slaughter and so on. A share is also put aside for the poor. The capture of a school of pilot whales, was an absolute windfall to the islanders, and even now there are wild scenes following the slaughter of *grindehval*, as the Faeroese call them.

class	**Mammalia**
order	**Cetacea**
family	**Delphinidae**
genus & species	***Globicephala melaena*** *others*

Pink-footed goose

The pink-footed goose is a small variety of the bean goose. The latter is so-named because it arrives in England in October, at the time of the bean harvest and then stays to feed on the beans left lying in the fields. There are two basic types of bean goose; the forest bean geese have long, slender bills, while the tundra bean geese, stockier birds, have shorter deeper bills. The pink-footed geese are the latter type. Their length from bill to tail is 24-30 in. The head and neck are dark brown, the underparts light pinkish brown and the wings and tail ash grey with white edgings. The feet are pink and so is the bill except the base and tip, although it may very occasionally be wholly pink.

Bean geese breed in the tundra and forest zones, from Greenland to eastern Siberia, but the pink-footed goose is restricted to eastern Greenland, Iceland and Spitzbergen. In the winter they migrate to Britain, northern France, Belgium, Holland and Germany. They occasionally turn up in North America, Russia and other parts of Europe.

Wary geese

During the winter pink-footed geese gather in very large flocks on sandbanks, moors, in estuaries, flooded marshes and around coasts—all places where they are unlikely to be disturbed. As is usual with geese, pink-foots are extremely wary and difficult to approach. Pink-footed geese arrive in their winter quarters in September and October, having migrated from the breeding grounds, with only a few stops, in the Faeroes or Scandinavia. They fly in skeins of over 1 000 geese with family parties of adults and goslings keeping together. When they arrive, weary and hungry, they are less wary than usual and for a few days it is possible to get nearer to them before they recover their strength. The flocks stay south until April or May.

Grazing and gleaning

In the autumn and winter pink-footed geese feed in stubble fields, usually of barley, but they also eat young wheat and grass stems. On the breeding grounds they eat buds, stalks, seeds and leaves of many plants including willow, sedge, horsetails, chickweed and grasses.

Safe nesting places

By the time the pink-footed geese have reached the breeding grounds they have already paired off. All arrive within a few days and only a few more days elapse before the eggs are laid. Most pairs nest in loose colonies but some raise their broods singly, especially in the open tundra. If large numbers nested together in open country predators such as Arctic foxes would be attracted to such easy prey with devastating

▽ *Pink-footed goose in profile.*

Arthur Christiansen

results. The colonies are usually in more inaccessible places such as the talus, the piles of boulders that form at the bottom of cliffs, on moraines, cliff ledges or terraces. Some colonies are on islands in rivers. When on level ground the nests are built on hillocks or frost mounds where the sitting bird can get a good view of the surrounding country. The gander usually keeps a watch from a lookout point nearby.

The nest is a depression in the ground lined with grasses and other plants and with a considerable quantity of down. The 4–5 eggs, sometimes more, are incubated by the goose alone while the gander stands guard. The eggs hatch in just under 4 weeks. The chicks leave the nest within 48 hours and never return. Their parents lead them down to water when they leave the nest and a new roost is used each night.

The adults moult during the breeding season, shedding all their feathers simultaneously so they cannot fly until the new ones regrow. As soon as they and their young can fly, they migrate south.

Moments of danger

When they have moulted their flight feathers they are helpless and although the natural wariness of geese usually keeps them relatively safe from enemies, unless they are in an isolated place they will fall prey to Arctic foxes. Greater black-backed gulls, Iceland falcons, white-tailed eagles and Arctic foxes are also known to prey on the eggs and chicks of pink-footed geese in Iceland.

Goose round up

The Arctic breeding grounds of pink-footed geese are a comparatively recent discovery. The birds were first discovered breeding in Spitzbergen in 1855 and in Greenland in 1891. The colonies there were fairly small and many years passed before the main colonies in Iceland were discovered. The first clues came in 1921, but proof was obtained in 1951 when Peter Scott, James Fisher and Finnur Gudmundson travelled to the interior of Iceland and found over 2 000 nests at an oasis on a high plain. They ringed over 1 000 pink-footed geese to find where they spent the winter, catching them by driving them into nets. At that time of the year neither adults nor goslings could fly so they were easy to capture. Nearby they found the remains of U-shaped stone walls 36 ft long and 6 ft across the entrance. These were the ruins of goose pens that had been used by the Icelanders centuries before for rounding up flightless geese. Of course their purpose in capturing them was not for the study of the birds or their migration but to fill up their larders.

class	**Aves**
order	**Anseriformes**
family	**Anatidae**
genus & species	***Anser fabalis brachyrhynchus***

▽ *Winter feeding-grounds—pink-footed geese graze the stubble on a field in northern Europe.*

Arthur Christiansen

Pintail

The pintail is probably the most numerous duck in the world. It is the same length as a mallard, 22 in., except that the central pair of tail feathers are elongated, forming the pin-tail which may be as much as 4 in. long in males. The plumage of the male is distinctive, with a blackish-brown head and neck, and with a white collar running down the side of the neck and across the breast. The back and belly are patterned and there is a patch of white on the belly in front of a patch of black at the base of the tail. The female is very much like a mallard duck. The male goes into eclipse from mid-July to early September. The eclipse plumage is like that of the female but is darker on the upper parts and the 'speculum' of bronzy-green with a buff bar on the front, can be seen on the wings.

The pintail is distributed around the northern hemisphere and it migrates south in winter.

The Bahama pintail ranges from the Bahamas through most of South America and also breeds on the Galapagos islands. It has distinctive white patches on the sides of its face. Some pintails breed farther south than any other duck. There are subspecies of the northern pintail on the sub-Antarctic islands of Kerguelen and the Crozets, and South Georgia has its own separate species. These sub-Antarctic pintails are confusingly called teal.

Habitat destroyed

The vast inhospitable wastes of the Arctic tundra provide the breeding ground for the pintail which nests in the numerous scattered pools and lakes. Freshwater pools are preferred to brackish ones, and nests are not usually found on water surrounded by marshy ground. In the Galapagos there are very few stretches of freshwater where the Bahama pintail can live. A few years ago a large lake in a volcanic crater on the island of Fernandina was destroyed by an eruption, so robbing the Galapagos pintail population of most of their habitat. In Europe pintail prefer wintering around coasts and estuaries, whilst in India large numbers are found on inland lakes. This is unusual as pintail are usually seen in only small numbers on inland waters. On the sea, however, they may form flocks of over 1000, these large flocks being split up into small parties which mingle with other ducks rather than forming tightly-packed rafts.

Rarely dive

Pintail feed by paddling in the shallows, upending, or by uprooting water plants such as pond weed, sedge and dock. Acorns and grain from stubble, beetles, fly larvae, worms

Arthur Christiansen

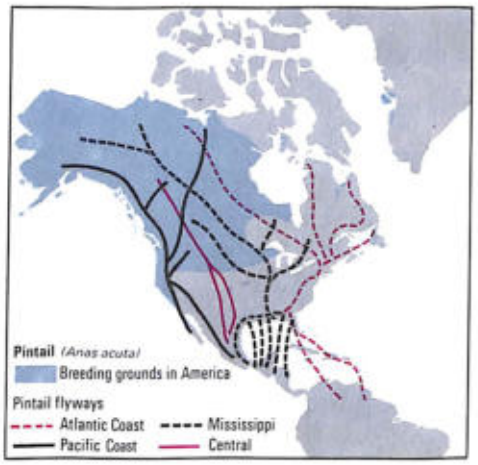
▷ *Pintail silhouettes.*

and tadpoles are also taken. Their winter diet includes seaweed and eelgrass. Pintail do not dive except to escape danger when unable to fly while moulting during eclipse or because of wounds.

Female distractions

The display courtship of the pintail is similar to that of the mallard (p. 1520) and there are aerial pursuits in which the female is chased by several males. Pintail often perform aerial dives, plunging at an angle of 45° from a great height, stooping with their wings stiffly outspread and slightly curved down. Just before hitting the ground they level out and glide a few yards off the ground for 100–300 yd.

The greatest concentrations of breeding pintails are probably in the tundra of Alaska where every small pool houses one or more pairs. Elsewhere the nests are fairly close together, sometimes a long way from water. These are no more than a down-lined hollow in the ground among marram grass, heather, rushes or other low plants. The 7–9 eggs are incubated by the female, and usually guarded by the male. The chicks hatch out after 22–23 days and shortly afterwards are led to the nearest water to feed. If disturbed, the chicks hide among water plants, and there are records of their mother performing distraction displays in which she approaches close to the intruder, and splashes about vigorously, swimming in circles. The young fly when 5–7 weeks old.



△ *Pintail breed throughout the northern hemisphere in Asia, northern Europe, including Britain, Iceland and central and western Canada.*

▽ *Sitting duck. A female pintail on her nest, a down-lined hollow in the grass. The favourite pintail breeding grounds are in the Arctic tundra, around the many scattered pools.*

Eric Hosking

Aerial highways

Ducks of the genus *Anas*, to which the pintail and mallard belong, make up three-quarters of the quarry of wildfowlers. In the United States in particular, vast numbers of wildfowl are shot every year as they fly across the country to and from the breeding grounds in the north. To protect the waterfowl there are stringent game laws and conservation agencies prepare suitable stretches of water for the birds to settle. Their task is made easier because the waterfowl, as well as other birds, travel along traditional routes.

Migrating birds usually take the line of least resistance. Birds of prey, for instance, cross the Mediterranean by the shortest sea routes, over the Straits of Gibraltar and the Bosphorus. Sometimes, however, the only way is over difficult ground. Pintails migrating in and out of India have to cross mountains, and the skeleton of one was found 16 000 ft up Mount Everest. In North America there are four well-defined migration routes that follow geographical features. These were discovered, and named 'flyways' by Frederick Lincoln, from information gathered from banded birds, mainly waterfowl of various species.

The flyways start in the tundra of Alaska and northern Canada, and continue down through the plains of Canada and into the USA. On the way, the ducks and geese from the Arctic are joined by hosts of other birds and finish on winter grounds around the Caribbean Sea or in South America. The most important flyway is that down the Mississippi Valley to the marshy shores of the Gulf of Mexico. Next in importance is the central flyway, also starting in Alaska but then running close to the eastern side of the Rocky Mountains. Along the coasts there are the Atlantic and Pacific flyways, one leading to the West Indies and South America, the other to the Pacific coast of Mexico and California. These flyways are less used because the winter climate of the coasts is less severe than in the centre of the continent. Therefore there is less pressure on the birds to travel south.

class	**Aves**
order	**Anseriformes**
family	**Anatidae**
genus & species	***Anas acuta*** *pintail* ***A. bahamensis*** *Bahama pintail* ***A. georgica*** *South Georgia pintail*

P. Morris

◁ *Surface feeder: pintail drake dips its bill. They sometimes upend and they often uproot water plants. The two elongated central tail feathers form its distinctive pintail.*

Pipefish

These eel-like fishes were given their name in the mid-18th century, when pipe stems were long and very thin. Today they would probably have been called pipe-cleaner fish. The shape of the body has led to such names as worm pipefish, snake pipefish and threadfish. There are over 150 species from 1 to 18 in. long, in tropical and temperate seas. All are long and very slender with long heads, tubular mouths and tufted gills. Instead of scales, they have a series of jointed bonelike rings encircling the body, from behind the head to the tip of the tail. Some have a small tailfin, in others there is none. The main fin is in the middle of the back.

The colours of pipefishes are usually dull: greenish or olive, like the seaweeds among which they live. Most have a slight banded pattern, which is particularly well marked in the banded pipefish of New Caledonia. Some are mottled and spotted. Some pipefishes can change colour, like the Florida pipefish, which is normally dark green when among eelgrass but goes light when among pale green weed. Others in American seas are muddy brown but turn brick-red when among red weeds.

Most pipefishes are marine or estuarine and a few are freshwater. The marine species live chiefly inshore, in shallow seas, but some live at depths of 50 ft or more, and one lives among the weed of the Sargasso Sea, off the coast of Florida.

Anthony Bannister: NHPA

△ *Pipefish portrait:* ***Syngnathus*** *shows off its intricate patterning. They often swim in a strange semivertical position with their pectoral fins vibrating so rapidly as to be almost a blur.*

▽ *A group of banded pipefish* ***Dunckerocampus caulleryi*** *patrol a coral reef off New Caledonia in the South Pacific.*

Vertical swimmers

Pipefishes in shallow waters and estuaries often live among eelgrass, the only flowering plant in the sea, with long swordlike leaves. They swim in a vertical position with the dorsal and pectoral fins vibrating in time with each other, driving the fish through the water in a leisurely fashion. The vibra-

tions of the dorsal fin are so rapid as to give the impression of a tiny propeller. They can also slip through the water with snake-like movements of the body. They can turn their heads from side to side, and use these movements for steering. The eyes can be moved independently of each other, as in chameleons. Pipefishes may also be found among seaweeds, at times in rockpools, in holes and crevices, and there are species in tropical seas that live in the interstices in coral rock rubble, almost like earthworms.

Fussy vacuum cleaner

Pipefishes have no teeth and they have been described as suffering from permanent lockjaw, with the locked jaws supporting the tubular mouth. They cannot pursue prey but do the next best thing. The mouth acts as a syringe and can suck in a small planktonic animal from 1½ in. away. When searching for food they may swim upright or in a horizontal position, wriggling and twisting the body, turning the head this side and that and thrusting among tufts of weed or into cracks and crevices. They seem to be selective, apparently scrutinizing each copepod or other small animal, tasting the morsel, and ejecting it forcibly if not satisfied. Some spiny larvae of crabs are inspected but left severely alone.

Sexes swap jobs

The main interest of pipefishes is in their breeding. They are related to sea-horses, the males of which have a pouch in which the female lays her eggs. The pipefishes are less simple. In some species the female merely lays her eggs on the underside of the male and there they stick. At the other extreme are species in which the male has a long pouch formed by folds of the surface growing down and meeting in the middle line. There are grades between the two; in some species there are merely two folds of skin in which the eggs lie. All pipefishes have, however, one thing in common: the male carries the burden of the offspring. In many of them the female does all or most of the courting.

Courtship has been fully studied in the Florida pipefish. The two swim round each other in the vertical position but with the head and front part of the body bent forward. They swim in decreasing circles until their bodies touch, when the male bends farther forwards and caresses the female with his snout. He becomes excited, wriggling his body in corkscrew fashion as he continues to caress the female with his snout. Finally, their bodies become entwined, she inserts her ovipositor into his pouch and lays some eggs. The male wriggles his body to work the eggs down into the pouch, after which the female lays more eggs, and this is repeated until the pouch is full. The eggs hatch and the larvae are shot out, one or a few at a time, by the male making convulsive movements. Even when able to swim freely the baby pipefishes may dive back into the pouch in times of danger.

Submarine flirtation

It is not surprising that for a long time the male pipefish should have been mistaken for the female. It was not until 1831 that this was corrected, and it was many years later before they had been studied sufficiently to show how completely the roles of male and female were reversed, even to the female doing the courting. The female broadnosed pipefish of the Mediterranean, for example, courts the male for several hours before he responds. Then he swings his body from side to side, through a right angle, reminding one of the wriggling and swaying of the bashful suitor. This facetious idea receives support from the further behaviour of the female of this species who seems to flirt preposterously, courting one male after another, even mating with several in turn.

RH Noailles: Jacana

△ *Moment of birth for a father! In some pipefish the male carries the developing eggs in a pouch, the female inserting them as the climax to an intimate caressing courtship.*

▽ *Some* ***Syngnathus griseolineata*** *have pregnant pouches seen halfway along their bodies.*

class	**Osteichthyes**
order	**Gasterosteiformes**
family	**Syngnathidae**
genera & species	***Nerophis aequoreus*** *snake pipefish* ***Syngnathus acus*** *great pipefish* ***S. floridae*** *Florida pipefish* ***S. typhle*** *broadnosed pipefish* *others*

John Tashjian at Steinhart Aquarium

Pipistrelle

The pipistrelle or common bat, as it is called in Britain, is the most familiar as well as the smallest of European bats, although there are several other species of pipistrelle in continental Europe that are only slightly larger. It is recognisable by its jerky erratic flight and because it appears earlier in the evening than most other bats, sometimes coming out even in broad daylight. The jerky flight of pipistrelles gave rise to the ancient name for bats, which was flittermouse—German ***Fledermaus*** *—and another medieval name for bats was reremouse.*

Weighing only ¼ oz and with a maximum head and body length of 2 in., the pipistrelle is nevertheless of robust build, with short legs, broad flat head and a tail just over an inch long. The last joint of the tail is free of the interfemoral membrane joining the thighs, and is prehensile; the bat is thought to make use of this joint as a support when crawling up or down a vertical surface. The wingspan is 8—9 in. The calcar, a spur on the hindleg, reaches almost to the tail and behind it is a lobe of membrane, the postcalcarial lobe, an important feature of identification.

Except on the ears and wing-membranes where it is blackish, the somewhat silky fur of the upperparts varies from dark to light reddish brown. The underparts are paler and the undersurface of the interfemoral membrane has no fur. The muzzle is blunt with a wide mouth, and the short, somewhat triangular, ears, slightly notched on their outer edges, end just behind the angle of the mouth.

There are about 40 species of pipistrelle. The range of the common pipistrelle includes the whole of the British Isles and continental Europe, southwest Asia north-eastwards to Korea and Japan and eastwards to Kashmir, and also Morocco. Other species live in Madagascar, the Malay Archipelago, Australia, the Philippines and North America.

The pipistrelle lives in a wide variety of places, singly or in colonies which may be small or may contain hundreds of bats. It can be found, for instance, under roofs, behind drainpipes and gutters or in holes in woodwork and brickwork as well as in hollow trees and rock-crevices. Although the pipistrelle hibernates in the colder parts of its range, it is for a short period only: late October or November to March. A temperature rise of about 4—5 Centigrade degrees will awaken it and it will emerge from time to time for an hour's hunt for food. It may also move from one hibernaculum to another during winter.

Do my ears deceive me?

Hunting over a regular beat the pipistrelle flies at between 6 and 40 ft above the ground, uttering its shrill squeaks and capturing its prey on the wing. It feeds mainly on flies, particularly gnats, small beetles and other insects. It was once thought that the pipistrelle continued to hunt throughout the night, but it is more likely that it has periods of activity alternating with rest throughout the night, although it may not return to its roost until an hour or so before sunrise.

The bat uses its eyes to some small extent, but it relies mainly upon echo-location to find its way around and to capture prey. The frequent, ultrasonic squeaks bounce back from any solid object and, by interpreting the time taken for the echo to return, the bat is able to 'see' its surroundings. A bat probably carries a sound-picture of familiar territory, comparable to the visual memory of man. It appears, however, unable to assess size accurately. This is shown by the fact that a pebble tossed up into the path of a hunting pipistrelle will be followed down in an attempt at capture, although the pebble may be larger than the bat.

Eric Hosking

Ian Beams

△ *A resting pipistrelle bares its sharp teeth —good equipment for snapping up insects.*
◁ *Adult and young common pipistrelles sleep upside-down during the day, clinging on to a wall by their tiny claws.*

Delayed conception

Pipistrelles mate shortly before going into hibernation but fertilisation is delayed until the following spring. The single young is born between late June and mid-July after

SC Bisserot

◁ *Wings in the night. The common pipistrelle, the smallest European bat, is one of the first bats to appear in the evening and has a characteristic jerky flight.*

a gestation of 35–44 days. The American eastern pipistrelle has two mating periods, in late summer and early spring, but only one litter results, of 1–3 young, also born in June or July. The females of this species usually form 'maternity colonies' and the young are weaned and ready for independent flight at 3 weeks old.

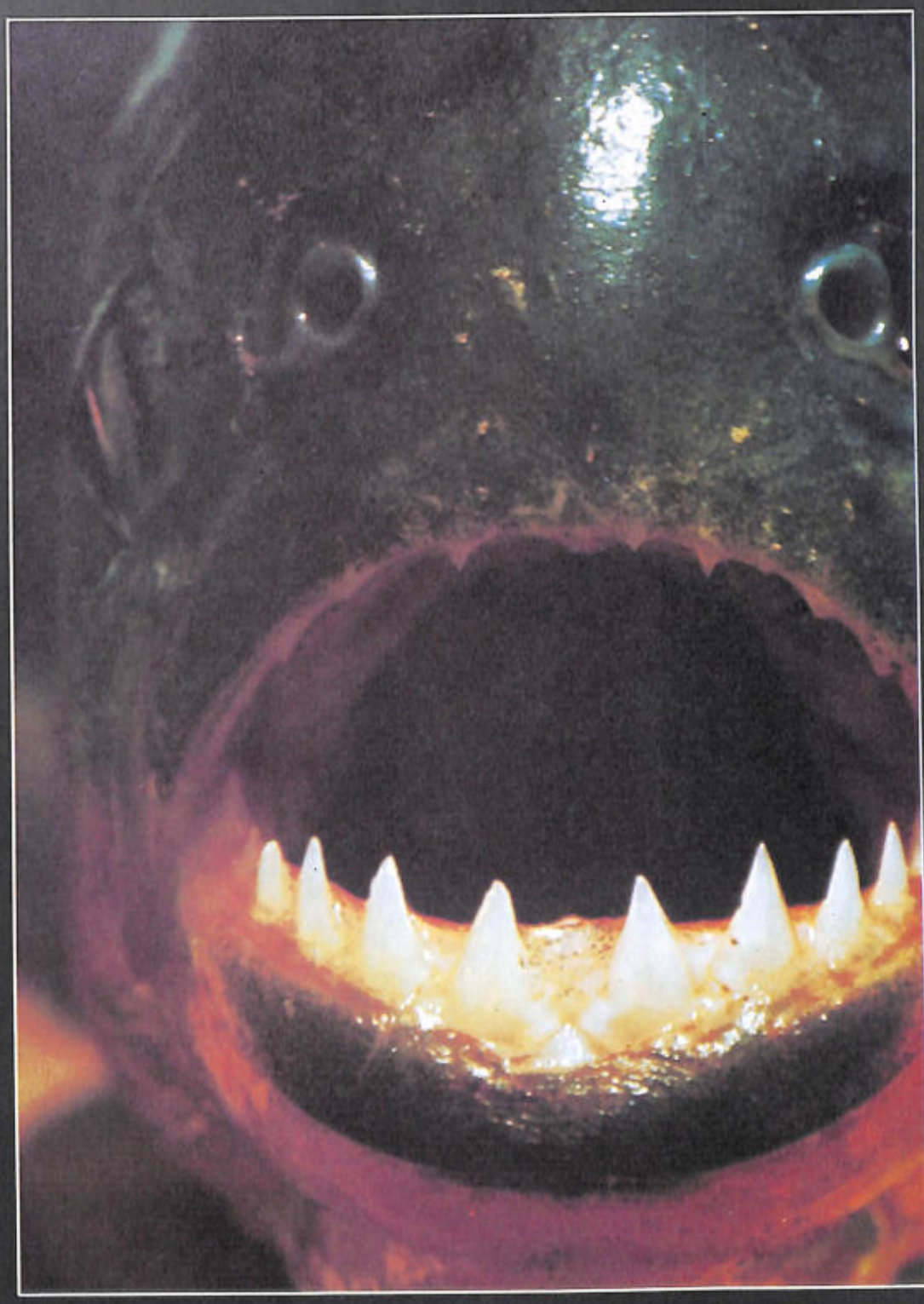
As in the European species, females of this American species are smaller than the males, which are 3½ in. long, including a 1½-in. tail, have a wingspan of 6 in. and weigh up to ¼ oz. Their fur is yellow-brown above and paler below, with blackish wing-membranes. Their food is chiefly small beetles and flies; larger insects are held in the interfemoral membrane to be eaten. The American western pipistrelle is similar in appearance and habits but is found westward from the Rockies to the Pacific coast.

Drinking on the wing

Although pipistrelles eat mainly insects, whose bodies contain 70% water, they do need to drink, a fact which often escapes the attention of those unaccustomed to seeing bats anywhere near ground level. Moreover, the pipistrelle's choice for hibernation is often a cave or similar hiding place where the air is humid, sometimes so much so that their bodies become beaded with moisture. This damp atmosphere prevents them from becoming dehydrated. During the summer, however, their roosts, under roofs for example, are hot and dry and they must drink. To get water pipistrelles use one of two methods. Either they land on the ground, for bats can scuttle like mice although more slowly, or they skim a pond or stream in the manner of swallows and martins, dipping their lower jaw into the water while in flight. A pipistrelle has been observed to do this several times in the course of a few minutes, swooping and manoeuvring over a pond, making use of the wind like a glider pilot.

Although it has been claimed that bats can swim, it is doubtful whether any of them, even the fish-eating bats of tropical America, deliberately take to the water; a strong argument against this claim is the number of bats found drowned annually in water butts. From time to time pipistrelles having landed on water, have been seen to 'row' themselves to shore, using their wings like oars, and there are scattered reports of other small bats doing the same.

class	**Mammalia**
order	**Chiroptera**
family	**Vespertilionidae**
genus & species	***Pipistrellus hesperus*** *American western pipistrelle* ***P. pipistrellus*** *common pipistrelle* ***P. subflavus*** *American eastern pipistrelle* *others*



Camera Press

△ *The gates of hell? A piranha displays its deadly teeth beneath its flaring nostrils.*

Piranha

Few accounts of travel in South and Central America fail to contain some references to the piranha or piraya, the small but allegedly very ferocious fish that inhabits the rivers of this region. In some places it abounds in such vast numbers as to be a serious pest, making the infested streams either very hazardous or quite impossible for fording or bathing.

The name piranha applies loosely to about 18 species, of which only 4 seem to be dangerous to humans. All are members of the genus ***Serrasalmus,*** *having a general similarity of appearance and habits. Some scientists, however, classify them differently. Most of the species average 8 in. in length but* ***Serrasalmus piraya,*** *of the River São Francisco in eastern Brazil, one of the most dangerous, may reach 2 ft. Most of them are olive-green or blue-black above and silvery or dark grey on flanks and belly. Some species have reddish or yellowish tinted fins. The colours seem to vary considerably from place to place and with age. For example, old specimens of the white piranha* ***Serrasalmus rhombeus,*** *found in the Amazon system and north-eastern South America, are often dark enough to be called black piranhas.*

The body of the piranha is deep, short and rather compressed from side to side. A large bony crest on top of the skull supports a keel on the back, and a similar keel on the belly is strengthened by a firm row of enlarged scales bearing sharp,

backwardly-directed points. The deep and heavy forepart of the fish is provided with a cut-water above and below. There is a fleshy adipose fin on the back between the dorsal and tail fins. The tail is slender and muscular and together with the broad, tough, blade-like tail fin helps to drive the body through the water with great force. As in all really swift fish the scales are very small. The most striking feature is the mouth. The massive lower jaw has relatively huge muscles operating it. The teeth are large, flat and triangular with very sharp points. These points merely pierce the skin, the rest is done by the edges, which are literally razor-sharp. The teeth of the upper jaw are similar but much smaller and fit exactly into the spaces between the points of the lower ones when the mouth is closed. The jaws are so strong and the teeth so sharp that they can chop out a piece of flesh as neatly as a razor. The fact that there is a reliable record of a 100lb capybara reduced to a skeleton in less than a minute shows the efficiency of the teeth.

A few of the smaller species are kept in aquaria, the most popular seen in tropical fish stores and public aquaria being ***Rooseveltiella nattereri,*** *the red or common piranha, up to 1 ft long and coloured red on the underside and fins.*

Some piranhas are found only in certain river systems, such as the Rio São Francisco, Rio Paraguay or Rio Orinoco, while others range over a wider area.

◁ *Piranhas take their pickings and leave. They hunt in shoals of up to several thousand so they often make short work of a carcase.*

Water alive with fish

Piranha hunt in shoals, sometimes of several thousands, so in places the water seems to be alive with them. Smaller fish form their staple diet, but any animal entering or falling into the water accidentally may be attacked. They often attack each other. It is said that they will instantly be attracted by blood in the water but apparently anything out of the ordinary will attract them.

Waterplant hatcheries

It is thought that piranha breed when the rainy season sets in about January or February. The female deposits her eggs on water plants or roots. On hatching, the fry stay attached to the vegetation in clusters until they have absorbed most of the yolk sac, and then become free-swimming. *Serrasalmus spilopleura* is one of the few species which has been seen breeding in an aquarium. The female deposited her eggs carefully on aquatic plants, which is unlike the usual erratic spawning behaviour of most of the other members of its family. The male guards the eggs as well as the fry, when they hatch. These became free-swimming about 5 days after hatching.

Ferocity exaggerated?

The ferocity of the piranha has become almost legendary. Stories are told of a cow or a pig falling into a river, being stripped to a skeleton in a few minutes. One of the most famous stories is that of a man, fording a stream on horseback, who was brought down and killed by a swarm of piranha. Later the bones of horse and rider were found, picked perfectly clean, the man's clothes undamaged. It is probable that a lot of the stories have been exaggerated. Some travellers now say that they have waded in or swam in rivers infested with piranha shoals and have never been attacked.

Marcel Cognac

Marcel Cognac

Yet others say they have come on villages where hardly a native had not suffered the loss of a toe or finger. It is difficult to know what to believe but there must be some truth in the danger from these fish.

It is possible that the ferocity of the piranha may vary with the species and from place to place, and it may be that they are much more aggressive at the beginning of the rainy season when the males are guarding the eggs. This could also explain why it is that they will attack bathers at certain places in a river, where perhaps they have laid eggs, leaving others unmolested not far away. Nevertheless, those aquarists who keep these fishes admit to treating them with respect and taking extra care in feeding them, or when netting them to transfer them from one aquarium to another.

△ *No table manners. Piranhas have pointed teeth with razor-sharp edges which bite out neat chunks of meat from their victim.*
▽ *Cleaned out. A carcase is left to the flies.*

class	**Osteichthyes**
order	**Cypriniformes**
family	**Characidae**
genus & species	***Rooseveltiella nattereri*** *red or Natterer's piranha* ***Serrasalmus piraya*** *piraya* ***S. rhombeus*** *white or spotted piranha* ***S. spilopleura*** *common piranha* *others*

Marcel Cognac

FGH Allen

Pitta

Some of the pittas are among the most colourful birds in the world. The name pitta is a latinization of a native word meaning small bird. There are about 23 species, about the size of a thrush, with long legs, large feet and very short tails, giving them a very 'front heavy' appearance. They are also known as painted thrushes, ground thrushes and jewel thrushes because of their similarity to true thrushes. The plumage of pittas is immensely rich and varied, being made up of broad patches of colours including greens, reds, yellow and blues. The Indian, Bengal or blue-winged pitta is aptly known in India as the 'nine-coloured one'. It is about 7 in. long. The head is reddish-yellow with a thin black band over the top of the head and broad ones running through the eyes. The back and wings are mainly green, the rump and 'shoulders' pale blue. The chin and throat are white and the rest of the underparts reddish-yellow except for a scarlet patch under the tail. Perhaps the most beautiful pitta is Steere's pitta that lives in the mountain forests of the Philippines. It has a black head, white throat, sky blue, black, and scarlet underparts and a green and blue sheen on the back and wings.

Pittas live in forests, jungle or tropical scrub. Most live in southeast Asia, especially in the Malayan peninsula and archipelago, but some are found as far east as Japan and Australia, where the noisy pitta is known as the dragon bird because of its gaudy colours. There are also two species living in Africa.

Arthur Christiansen

◁ *Banded pitta,* ***Pitta guajana.*** △ *Green-breasted pitta. Pittas tend to keep their feet on the ground, hopping around on their strong legs.*

Heard not seen

The brilliant colours of these birds are not noticed in the forests as they are secretive and shy and would be easily overlooked if it were not for their calls. These are loud two or three note whistles, trills or grunts. When one pitta calls, others answer it; the Indian pitta sets up choruses of whistlings particularly at sunrise, and it is known in Ceylon as the '6-o'clock bird'.

Pittas spend most of the time on the forest floor hopping on their strong legs but they also ascend into the trees to sing and roost. Some flick their tails continuously like a moorhen. Some pittas are migratory. The Indian pitta moves into Sri Lanka for the breeding season while those breeding in temperate regions such as Japan and Australia migrate to the tropics. The African pitta breeds from central Tanzania to South Africa but moves northwards in winter to Uganda. The tropical pittas have no migrations but probably move about in search of fresh feeding grounds.

Ground feeders

Pittas forage very much like thrushes; they examine the ground with their heads cocked to one side hopping forward to stab at an animal or to flick leaves aside and pick anything that is disturbed. They feed on small animals that live on the ground, including earthworms, termites, beetles, centipedes and small lizards. Also like thrushes, noisy pittas feed on snails, carrying them to small stones or logs to smash open their shells.

Pugnacious pittas

Pittas lead solitary lives, not tolerating any other pittas in their territories, and becoming very aggressive during the breeding season. It is possible to lure the Indian pitta to within 20 ft by imitating its whistle. Some pittas, such as the African pitta, have a short display flight. They leap up from their perch

Harry & Claudy Frauca

△ *Proud snail smasher. The handsome* ***Pitta versicolor*** *feeds mainly on land snails.*

onto a branch, then fly in a small circle back to the perch. The flight is accompanied by a buzzing noise which is probably made by the wings. When the Indian pitta sees a rival it flashes its wings and tail, showing off its brilliant colours, especially the white patches on the wings that are normally hidden when it is perched on a branch.

They breed when food is most abundant, from February to April in tropical Asia, from November to February in Africa and Australia, and May to August in the northern part of the pittas' range. The nest is an oval domed mass of twigs and leaves. The entrance is in the side and leads along a short tunnel to the nest chamber which is lined with leaves and rootlets. The nest is usually in a bush near the ground but may be as high as 30 ft up a tree. The eggs are round and glossy, and in India and Malaya a clutch of usually 3 or 4 eggs is laid, with fewer in Australia and South Africa. Both parents take part in incubating the eggs and feeding the young.

Discriminating pitta

In general, the small birds of tropical Asia have not been well studied, but one green-breasted pitta received more than its share of attention from Tom Harrisson, who has contributed so much to our knowledge of the wildlife of Malaysia. This pitta was kept in an aviary, where it became quite tame, while its food preferences were studied. It had a voracious appetite, eating more than its own weight of food every day. Its favourite food was earthworms followed by caterpillars provided that they were not hairy, cockroaches and small grasshoppers. Other animals formed second choice, and were eaten only when the favourites had been consumed. These included spiders, large wasps and large snails. Surprisingly a 3in. beetle and a 6in. centipede were completely consumed.

Observations such as these on the tastes of captive animals are instructive, especially when it is difficult to watch them feeding in the wild. It is particularly interesting to find why certain animals are not eaten by them, because they are too hard, too fast or poisonous, for instance. Even better, it is interesting to find that such animals as the centipede are eaten by the pitta. Experiments like this can be made on almost all pets, but it is worth remembering that individual animals, like people, have their fads, irrational though they may be.

class	**Aves**
order	**Passeriformes**
family	**Pittidae**
genus & species	***Pitta angolensis*** *African pitta* ***P. brachyura*** *Indian pitta* ***P. sordida*** *green-breasted pitta* ***P. steerei*** *Steere's pitta* ***P. versicolor*** *noisy pitta*

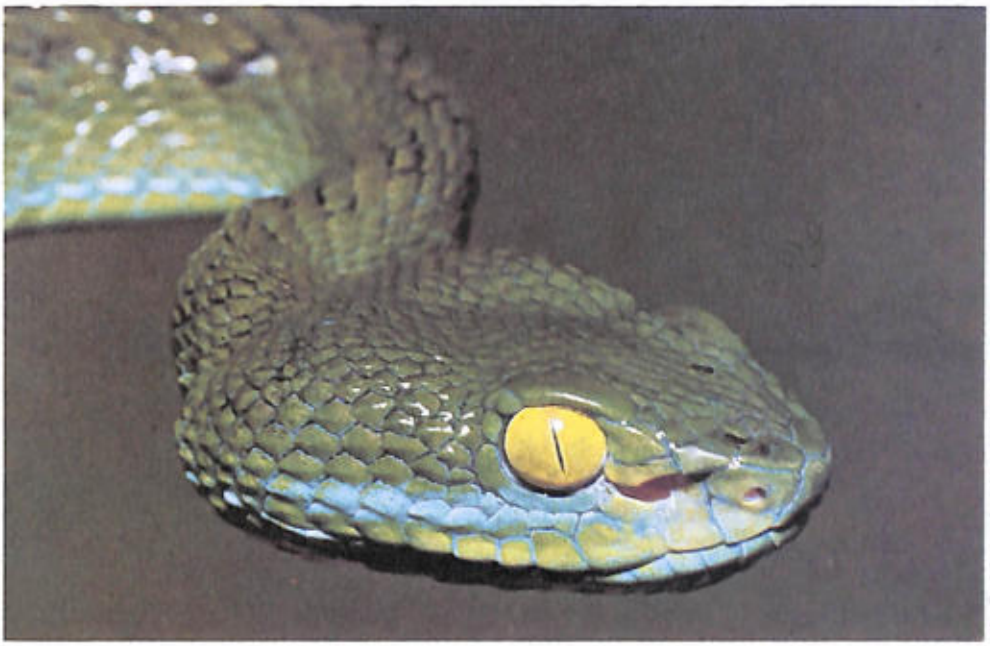
Pit viper

Some of the most-feared snakes are to be found among the 60 species of pit vipers (family Crotalidae) including well known forms like the fer-de-lance, which has already been dealt with (see p. 898), and the sidewinder (see p. 2252) and the rattlesnakes (see p. 2049). Here we shall consider others, such as the American water moccasin, copperhead and bushmaster, as well as the Asiatic pit vipers.

Pit vipers are a diverse group with several interesting specializations, which is why we have given them three entries. Here, while dealing with the family in general terms, we pay special attention to what has been called their sixth sense, the two pits on the head that give them their name.

Pit vipers are solenoglyph (see night adder, p. 1712). That is, they have fangs which fold back and are erected when about to be used. Most are land-living, some are tree-dwellers, a few have taken to water and others lead a partially burrowing life. Water moccasins are heavy-bodied, up to 5 ft long, and while living on land they readily take to water when disturbed and they hunt in water. They are slate black to olive or tan with indistinct brown bands. The copperhead, a brown snake with hourglass markings along the back, is up to 3 ft long. It lives in rocky outcrops and quarries and among piles of rotting logs. The bushmaster is the longest of the American pit vipers, up to 12 ft, mainly grey and brown with large diamond blotches along the back. It has large venom glands and unusually long fangs. Its generic name ***Lachesis*** *is from one of the Fates that influenced the length of life of people—a grim pun by the scientist who named it, for the bushmaster is one of the most dangerous of snakes. The Asiatic pit vipers are of two kinds, tree-dwelling and ground-living, the first having prehensile tails that assist their climbing. The Himalayan pit viper lives at altitudes of 7 000—16 000 ft, sometimes being found even at the foot of glaciers.*

The Asiatic pit vipers are found mainly in eastern and southeast Asia with one species extending as far west as the mouth of the River Volga. Wagler's pit viper is kept in large numbers in the Snake Temple in Penang. The water moccasin and the copperhead are widespread over the eastern and middle United States, the bushmaster ranges from Costa Rica and Panama to northern South America.



John Tashjian at Steinhart Aquarium

△ *Head first:* ***Trimeresurus gramineus.***
▷ *Overleaf: Pit viper* ***Bothrops schlegeli.***

Warm-blooded food

The warning posture of the water moccasin, mouth open showing its white lining, gives it the alternative name of cottonmouth. It also vibrates its tail at the same time, like its relatives the rattlesnakes, although it has no rattle to make a warning sound. Pit vipers, apart from their pits, are very ordinary snakes. Some take a wide range of foods, like the water moccasin which eats rabbits, muskrats, ducks, fish, frogs, other snakes, birds' eggs, and nestlings. The copperhead eats small rodents, especially the woodmouse, other snakes, frogs, toads, and insects, including caterpillars and cicadas. The bushmaster, by contrast, takes mainly mammals, and pit vipers generally tend to hunt warm-blooded animals more than cold-blooded, as one would expect from snakes with heat-detector pits. They have one on each side of the head between the eye and the nostril. Using these a pit viper can pick up the trail of a warm-blooded animal.

'Seeing' heat

Each pit is $\frac{1}{8}$ in. across and $\frac{1}{4}$ in. deep. A thin membrane is stretched near the bottom and temperature receptors, 500—1 500 per sq mm, are packed within this membrane. These receptors are so sensitive they can respond to changes as small as 0·002 of a C°, and they allow a snake to locate objects 0·1 of a C° warmer or cooler than the surroundings. In more understandable terms a pit viper could detect the warmth of the human hand held a foot from its head. The membrane with its receptors can be compared to an eye with its retina. The overhanging lip of the pit casts 'heat shadows' onto it, so the snake is aware of direction, and since the 'fields of view' of the two pits overlap there is the equivalent of stereoscopic vision, giving a rangefinder. A pit viper hunting by day has the advantage of being able to follow an animal's heat trail through low vegetation after the animal has passed out of sight. It could, of course, do this equally well by scent. The facial pits come into their own in night hunting, when prey can be tracked by scent with the facial pits guiding the final strike. At first it was thought they had something to do with an accessory aid to smell or as an organ of hearing—snakes have no ears. Another suggestion was that they might be organs for picking up low-frequency air vibrations. Then, as late as 1892, it was noticed that a rattlesnake, one of the pit vipers, was attracted to a lighted match. Then came the discovery that pythons have pits on their lips that are sensitive to heat. The first experiments on pit vipers were made in 1937, and left no doubt that the pits are heat detectors and further studies since have shown just how delicate they are.

Snakes in cold climates

Pit vipers usually bear living young. There are a few exceptions, the bushmaster being one, and that lives in the tropics. Pit vipers extend from the Volga across Asia and across America. There may be a direct connection between these two things. One of the advantages of bearing living young, as against laying eggs, is that the offspring are protected not only against enemies but also against low temperatures until they are at an advanced stage of development. At some time pit vipers must have crossed the land bridge that used to exist where the Bering Straits are now. This is well north, and it would have been far easier for snakes able to bear live young to survive in these latitudes and so make the crossing. It probably explains also why the Himalayan pit viper can live so near glaciers, and why the most southerly of all snakes is a pit viper named *Bothrops ammodytoides*, living in the Santa Cruz province of Argentina.

class	**Reptilia**
order	**Squamata**
suborder	**Serpentes**
family	**Crotalidae**
genera & species	***Ancistrodon contortrix*** *copperhead* ***A. himalayanus*** *Himalayan pit viper* ***A. piscivorus*** *water moccasin* ***Trimeresurus wagleri*** *Wagler's pit viper*

Plaice

The plaice is one of the best known of the flatfishes and commercially the most important. It has a flattened body, with the dorsal fin extending from the head almost to the tailfin, and the anal fin from behind the gill cover to the same point. The brownish, upper, or right side is marked with red spots, each of which is surrounded by a white ring in the adult. These may be pale when the fish has been resting on whitish pebbles. The underside is pearly white but can be partially or wholly coloured, a condition known as ambicoloration. It may take the form of scattered brown or black spots or patches on the white undersurface. Alternatively, only the hindend may be completely coloured as on the upper surface, including the red spots. When the pigmentation extends along the whole underside the undersurface of the head is usually white, but in exceptional cases even this may be coloured. The mouth is twisted, with the lower, or blind, side more developed and armed with a greater number of teeth. The small scales are embedded in the skin and there are bony knobs between the eyes. Plaice can grow to almost 3 ft long, but the usual size is much less.

They range from Iceland and the White Sea, along the coasts of Scandinavia, south through the North Sea to the coasts of France and the western Mediterranean. Plaice are not identical throughout their range but are split into a number of races. They vary in area of distribution, time and site of spawning, and in their degree of pigmentation.

Living magic carpet

Plaice live on sandy, gravelly or muddy bottoms, slightly buried, swimming just off the bottom at intervals through the day and night. They are said to be demersal or bottom-living fishes. They swim with vertical undulations of the flattened body, like a living magic carpet, then, holding the body rigid, they glide down. On touching bottom they undulate the fins to disturb sand or mud, which then settles on the fins, disguising the outline of the body. In this position a plaice breathes with a suction-pump action of the gill-covers.

Young plaice seem to go into a state resembling hibernation in winter. They remain quiescent in shallow water, slightly buried in the sand. At the appropriate time they move from shallow to deeper water.

Chisel and grinder

The teeth in the jaws of a plaice are chisel-like, but the throat teeth are blunt crushers. The food is mainly small molluscs but other small bottom-living invertebrates, such as worms, are eaten. Plaice swim over the shore at high tide to feed on the cockle and mussel beds. They hunt by sight not raising the head much off the bottom, but shooting forward horizontally with great accuracy to take the prey. Very small molluscs are taken whole into the stomach. Larger ones are crushed by the throat teeth. They also bite off the siphons of molluscs or the heads of worms sticking out of tubes.

Prolific spawnings

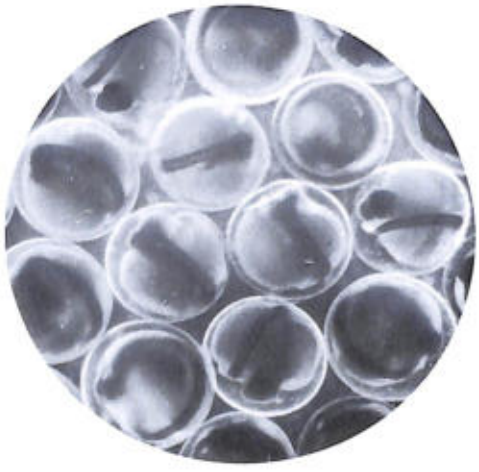
There is little in their outward appearance to tell male from female, but at spawning time if they are held up to the light the female roe shows as a small dark triangle. The male roe is a curved rounded line. The males reach the spawning grounds first and are still there after the females have gone. Spawning time differs from one part of the sea to another. Off the east coast of Scotland it is from early January to May, with a peak in March. In the Clyde estuary, on the west coast of Scotland, it is from February to June. In the southern North Sea it is from October to March.

To spawn, two plaice swim about 2½ ft off the bottom, the female lying diagonally across the male, releasing a stream of eggs while he emits a stream of milt. Spawning lasts less than a minute, after which the two separate and return to the bottom. Each female lays 50–400 thousand eggs, the number depending, it seems, on the length of the fish. The transparent eggs, each in a tough capsule, are just under $\frac{1}{13}$ in. diameter. They float at or near the surface, and many are eaten before they can hatch, which they do in 8–21 days, according to the temperature of the water. The larvae are about $\frac{1}{4}$ in. long, without mouth or gills, and with the remains of a yolk sac attached which supplies them with food. This is the most vulnerable part of the life of a plaice. Apart from those eaten by other animals only 1 in every 100 thousand survive the first few weeks of larval life, or 2–5 for every pair of parent plaice. Although this seems disastrous the figures are put in perspective by the knowledge that in one area alone, halfway between the mouth of the Thames and the coast of Holland, 60 million plaice come together each year to spawn. The adults are probably protected by their colour and their habit of lying buried, but seals find them, and predatory fishes, such as cod, eat the small ones.

Plaice are of great economic value but of the tens of millions of plaice eaten each year in Europe, few are eaten at the right moment. Plaice has the best flavour when it is cooked immediately after being caught. The sole however, develops its characteristic taste 2–3 days after death due to the decomposition of the flesh with the formation of different chemical substances.

Baby food

As the contents of the yolk sac are being used up, the larval plaice starts to feed on diatoms. At this stage it has the normal fish larva shape, giving no indication of the adult shape to come. As it grows it graduates from small diatoms to larger diatoms then to larvae of small crustaceans, such as copepods, and molluscs. At this stage an important item is the planktonic food *Oikopleura*. After 2 months the larva gradually metamorphoses into a young flatfish, this takes about 2½ weeks. The body becomes flattened from side to side, the young plaice starts swimming on its side, the skull becomes twisted by growing more quickly on one side than the other, causing the left eye to be swung over to the right side. At the same time the young plaice leaves the upper waters for the seabed, settling on its left side, so its right side and both eyes are uppermost. As these changes have been taking place the young plaice (still only ½ in. long) has been carried by currents to its inshore nursery ground.



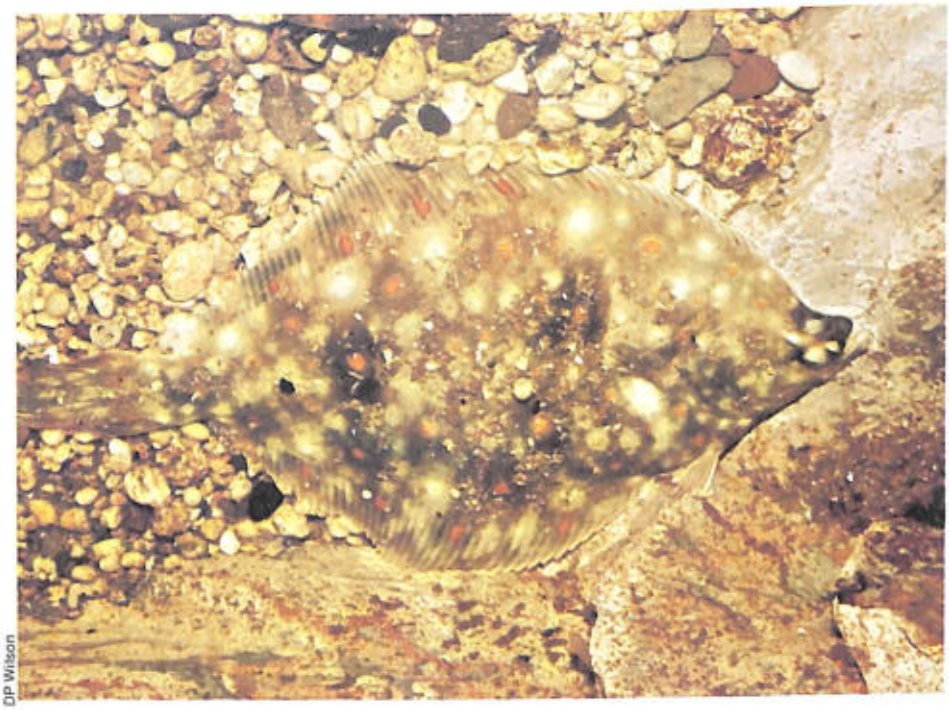
Plaice eggs with developing embryos.

Larva lives in plankton, off its yolk sac.

The account given above of the feeding of the larvae is only a generalization. The food taken varies in different places, the plaice taking whatever is available. In Scottish coastal waters they eat mainly worm larvae, crustacean eggs and larval molluscs. Off Plymouth, copepods and other small crustaceans are eaten, in the Irish Sea the larvae feed on small copepods, and spores of algae, and in southern North Sea it is mainly *Oikopleura*. The survival of the larvae can be seriously affected if supplies of these foods are low in a given area.

How they grow

After the ½in. young plaice has settled on the bottom it reaches 2¾ in. by the age of 1 year, 5 in. by 2 years, nearly 8 in. by 3 years, 10½ in. by 4 years and 13 in. by 5 years of age. These figures are for females, the males being smaller. On average, the males reach



DP Wilson

sexual maturity in 2–3 years, the females in 4–5 years. The figures must be read as approximations because average sizes of plaice have been found to vary: 17 in. in the North Sea, 15 in. in the English Channel, 13 in. in the Kattegat and 10 in. in the Baltic. These are, again, merely examples to show how size can vary, with environmental conditions. A 2ft plaice is 20 or more years old, and a 33in. plaice, which is one of the largest recorded, would be about 40 years old.

Plaice life history

Like many marine fishes the plaice lays a large number of eggs to offset heavy predation. The dramatic part of the life cycle occurs after 2 months in preparation for life on the seabed. The body becomes flattened from side to side; the skull is twisted by growing more quickly on one side than the other, causing the left eye to be swung over to the right side; then the young plaice settles with both eyes uppermost.

As yolk sac is used up the mouth develops.

Left eye migrates as larva swims on its side.

Eye migration complete, plaice settles on bottom.

Rh Noailles, Jacana

◁ *Face to face with the adult plaice. With distorted mouth and transposed eye it now lives permanently at the bottom of the sea, lying on its left side.*

In this plaice the upper surface is mottled light grey to suit its background of shell-gravel. The plaice in the top picture has a brown mottling because it is lying on differently coloured sandy gravel. A plaice can change its colour and patterns to blend in with its background. A hormone is secreted which alters the shape of the pigment cells thus changing the colour of the plaice's body.

class	**Osteichthyes**
order	**Pleuronectiformes**
family	**Pleuronectidae**
genus & species	***Pleuronectes platessa***

Plains-wanderer

These unusual, and now rare, Australian birds, also called collared hemipodes, share with their relatives, the buttonquails, and with painted snipe and phalaropes, the unusual feature of having dominant females. The female plains-wanderer is 5 in. long, 1 in. longer than the male, and has brighter plumage. The plumage is not gaudy but has intricate patterns of reddish-brown, buff and black. The wings are short and rounded. At one time the plains-wanderer was classified with the buttonquails (p. 474), to which it is very similar in appearance, but it has certain structural differences; it has a hind toe, and pointed rather than oval eggs.

Plains-wanderers live in southeastern Australia, from Lake Frome in the west and as far north as central Queensland in the east. They seem to be most abundant in Victoria. They stick to the dry plains and grasslands, avoiding the scrub regions where the buttonquails live.

Reluctant fliers

Plains-wanderers are usually active at night and move about in pairs or family parties rather than in flocks like their relatives. They migrate in search of feeding grounds, flying with rapidly whirring wings. Usually, however, they are very unwilling to fly. If disturbed they run through the grass, occasionally rising on tiptoe to peer around, or freeze, crouching motionless, and it is sometimes possible to catch them by hand.

The food of the plains-wanderer is mainly seeds of grass and other low plants, together with some insects.

Paterfamilias

The breeding habits of the plains-wanderer have not been studied in detail, but it is known that the female takes an active part in courtship and that the male incubates the eggs and guards the chicks. Whether the female mates with several males, as in buttonquails, is not known.

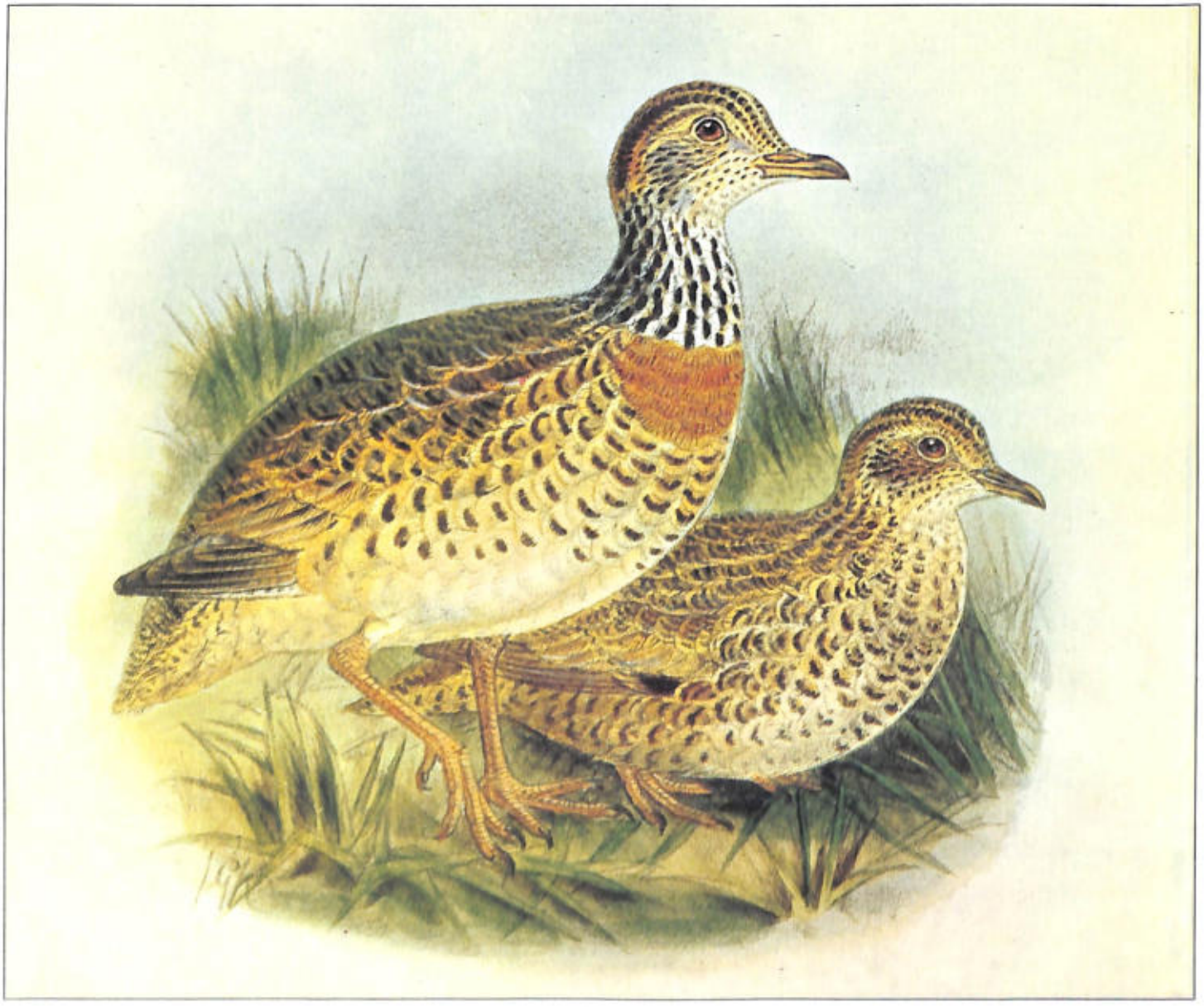
The nest is a grass-lined depression usually sheltered by tall grass or a bush. There are four eggs to a clutch, pale yellow or green with grey spots. The incubation period is not known but the chicks leave the nest shortly after hatching.

Causes of decline

The plains-wanderer is one of the growing number of animals that is becoming rare or extinct before their habits have been studied. In recent times some birds have become extinct before their eggs and incubation periods have been described. At one time the plains-wanderer was quite common and even now it is not so rare as to be put on the endangered list, but since Europeans settled in Australia its life has become more and more precarious. The grasslands have been transformed by agriculture; even stock farming drives out the plains-wanderer because sheep eat the seed-bearing plants on which it lives. Introduced rabbits, and fires, have had the same effect, and those that survive fall prey to foxes and feral cats.

class	**Aves**
order	**Gruiformes**
family	**Pedionomidae**
genus & species	***Pedionomus torquatus***

Plains-wanderers: the female has an orange bib.



Plankton

Plankton is a word of Greek derivation meaning literally 'that which drifts'. For this reason the term is applied to aerial, freshwater or saltwater drifting inhabitants. In this instance, though, we are going to consider the marine forms—by far the most spectacular and colourful of all 'drifters'.

Just because these creatures drift at the mercy of the great oceanic currents, the rapid shoreline undertows and the wind-blown surface currents, it does not follow that they are inactive. Indeed perhaps the most noticeable feature of a plankton sample is that every animal quivers, jerks and undulates with activity. Under the microscope the swimming movements often seem efficient and fast. Nonetheless the progress, when compared with the forces and speeds of oceanic currents, is very limited indeed. Some of the more capable swimmers do, however, manage to migrate vertically and so pass from one current of water to another. In this way, by dropping from, say, an east-going current into a lower west-going current, the tiny animal can 'ride' the currents to maintain its position over the sea floor or control its drift.

Community members

Drifting animals, large and small, may be found at any depth in the oceans, but the majority are confined to the upper one hundred or so feet. Plankton communities are comprised of both animals and plants, and in the same way that land animals feed on plant growth or upon each other, so also do these small highly specialized drifters. In general the plant members of the community have no means of swimming. They are browsed upon by the herbivorous individuals of the animal or zoo-plankton. These plant eaters, in turn, are caught and devoured by carnivorous animals. These may then be the victims of non-planktonic, predacious marine animals, like fish or squids or even some whales. We find, therefore that even in this world of diminutives there is just as well defined a food web or series of food chains as in other animal or plant communities. Basically the energy is derived from sunlight filtering through the surface waters, being converted to vegetable food by the plants and so being passed on to animal members of the plankton. It is because the energy is derived from the sun that most of the organisms are found near the surface.

We have made mention of the size of the planktonic organisms by referring to them as small. We should elaborate a little though and point out that most are small. There are, however, a large number of jellyfish which are truly planktonic and which are far from small. For instance the common orange-brown *Cyanea* jellyfish has an Arctic relative that may be 6 ft across the bell and have tentacles 18 ft long. The Portuguese man-o'-war may have tentacles up to 50 ft in length. At the other end of the scale many planktonic organisms are unicellular and no bigger than an amoeba. Indeed there are large numbers of amoeba-like creatures in the plankton which have within their microscopic bodies tiny transparent skeletons of perfect symmetry and yet they are so small as to be invisible to the naked eye. The vast majority of planktonic organisms, though, are about the size of a water flea, or between the size of a pin-point and a pin-head. The oceans of the world teem with countless billions of these animals and plants and every swimmer must have swallowed dozens with each untimely gulp of sea water.

Perhaps one of the most intriguing facts about plankton is that many of the creatures are the minute young or larval stages of much bigger, often common, shoreline or open-water adults. In fact one vast topic within the subject of plankton is the study of these 'larval forms'. In the same way as a frog begins its life as a tadpole or a moth as a caterpillar, so a starfish begins its existence as a bipinnarian or a sea snail as a veliger. The larvae of the familiar sea-shore animals are usually small, very highly specialised, and beautifully adapted to a drifting existence. The adults are usually adapted to a sedentary or creeping existence. Because of this extreme larval specialisation it is not surprising to find that these planktonic stages of a life cycle are completely and utterly different in appearance from the adult forms.

Pasture of the oceans: the diatoms such as these ***Rhizosolenia*** *and* ***Guinardia*** *are browsed upon by the many larval forms found in the plankton.*

DP Wilson

Unrecognisable offspring

Because the young stages look so dissimilar to their adult counterparts they were named as separate animals when they were first found and studied by biologists. The planktonic larva of the eel was called *Leptocephalus*, now it is the eel leptocephalus larva. The sea cucumber's youngster was named *Auricularia*. Now it is called the auricularian larva of a sea cucumber! The Latin names usually refer to a particular characteristic; 'auricularia' refers to an ear-like shape and 'leptocephalus' to a flat-headed appearance.

Some of the first larvae to be linked with their correct adult form were the *zoeae* larvae and *megalopa* or second stage larvae of crabs. Barnacle larvae were also recognised early on—about 100 years ago; they start as *nauplii*, pass through six very active stages and then turn into little bivalved settling larvae which attach themselves to rocks and metamorphose or 'change their form' into barnacles as we know them on bottoms of boats and rocks. The nature of the final change is similar to that of a tadpole or caterpillar. After a time of feeding and growth and sometimes skin change, there is a sudden brief period of more rapid change and the little larva appears as a diminutive adult, often very small but unmistakably the final stage. Sometimes one is lucky enough to catch a larva in this state of change and then it is well worth studying it carefully because within half an hour a tiny starfish, or barnacle, or snail perhaps, will appear.

Why do these shoreline animals have planktonic larvae? Simply, to distribute the species far and wide. How could barnacles colonise rocks and bottoms of boats, or a permanently fixed sponge disperse, without these mobile drifting larvae?

Sometimes these youngsters tell a biologist of the affinities of the adult. A barnacle is known to be a crustacean because its nauplius larva, the tell-tale feature, is a typical crustacean larva.

Many planktonic creatures are not yet fully studied. Many larvae are not linked with adults. In Jamaica two years ago, we filmed nearly 500 species of drifting organism. There were 7 or 8 new to science and yet they were common in the waters of Kingston Bay harbour. There is still a vast wealth of knowledge to be gleaned from these tiny creatures by both professional biologists and amateurs. The creatures are easily collected in a lady's stocking, suitably held open at the top end and with a small collecting vessel tied into the toe end in which a hole has been cut. Pulled slowly through coastal waters, any day of the year, but best in summer and spring, for ten minutes or so, the net will concentrate thousands of tiny throbbing animals in the collecting tube or tin. Under a microscope these will be seen to be of the most infinite beauty and variety.

Bizarre rarities

Every now and then you may come across one of the more bizarre rarities. Some of the most fantastic species are in fact very common. One such type, a copepod, occurs in Atlantic coastal waters, a bit like a water flea, but within its body it is equipped with two incredible binocular eyes. The retina is half-way back along the body and the lens system is mounted right at the front of the head. Between retina and lens is a condenser lens and the whole system is bounded by a well-defined binocular tube. The photograph opposite shows this unusual animal which is known to prey on other species not unlike itself.

Planktonic organisms are both fundamentally essential to the vast food chains within our oceans and are also remarkably spectacular. What is more, the study of the plants and animals and their interrelationships presents even the amateur with an open field for research.

Millions on the menu

The upper layers of the world's oceans are a vast soup of minute animals and plants: these drifting millions form the plankton. Marine life depends on them, from the immense baleen whales, which filter them direct from the water, to the predatory fish which eat them second-hand, in the bodies of their prey. (For full food chain see blue whale, p384.)
The animal part of the plankton is mainly crustaceans. It also serves as a drifting nursery to many larvae as they spread about the oceans (see barnacle p286, brittlestar p422, and hermit crab p1188). Four larvae are shown here, and one copepod, illustrating the beauty and diversity of this all-important but unfamiliar part of the animal kingdom.

Similarities between this sea cucumber larva and that of the acorn worm (page 286) gave scientists a link between major animal groups (× 150).

The first larval stage of a barnacle (p286). This will swim in the plankton, moult to form a cypris, anchor, then become adult (×130).

A copepod with eyes extended to form a pair of living binoculars. The feature opposite explains this curious structure (× 100)

One of the beautiful quirks of nature found in the plankton: the second (bipinnarian) stage in the development of a starfish (×70).

The coiled shell can already be seen within the star-like formation of this large veliger larva of a sea snail (×100).

©Oxford Scientific Films

Platy

This is a small tropical fish, a longstanding favourite with aquarists who shortened its scientific name ***Platypoecilus*** *to platy. The scientific name has now been changed to* ***Xiphophorus*** *but platy still persists as the common name.*

The wild platy is a deep-bodied freshwater fish of Mexico and Guatemala with a single dorsal fin and a relatively large, rounded tail fin. The males are up to 1¾ in. long, the females up to 2¼ in. The colour is brownish to dark olive on the back, the flanks being bluish and the underside whitish. The fins are almost transparent but in the male the pectoral fins are bluish at the tips and the anal and tail fins have a greenish-white band. Platys have also been called moonfish, a name seldom used now, because of the mark at the base of the tail fin which looks like a crescent moon. This mark is, however, variable and is missing in many individuals, and the colours also are variable even in the wild forms, in which black checkered and red varieties are not uncommon.

A second species, from another part of Mexico, was named ***Platypoecilus variatus,*** *or the variable platy, because of the range of colours it shows. It is similar to the first species and some experts treat the two as a single species.*

Rainbow colours

Platys are sometimes described as cheerful and not at all shy, which is just what an aquarist likes in his pets. They are easy to keep and they breed well, often producing colour varieties that can be selected and which breed true. They have, in fact, provided more colour varieties than probably any other aquarium fishes. Among these are the blue platys, in a wide range of blues, the red platys which at first were red, stippled with the black dots of the wild platy but are now bred in a pure deep red form, and the black platy which is green or yellow with a broad black stripe along the body, or may be all black except for the fins. Then a European aquarist found a yellow variety among his stock which became known as the golden platy, and when this was crossed with the wild form it gave the wagtail platy, which had a grey body and black fins at first, but later developed a yellow body and black fins. By breeding platys the aquarist was able to amuse himself with producing new colour varieties or even to study heredity.

Casual courtship

As well as eating animals such as water fleas and mosquito and midge larvae, platys take plant food and are especially fond of nibbling the green algae that grow on the sides of an aquarium. Courtship and mating are very brief. As the colours of the male intensify he either swims alongside the female or dashes about encircling her with outspread fins. Then suddenly they mate, in one quick movement, while both partners are still moving forward. Fertilisation is internal and the babies are born alive, 10–75 at a time. The growth and general welfare of the young depends on the temperature of the water; for example they grow noticeably faster and survive better at 35° C/97° F than at 39° C/103° F.

In aquaria platys readily hybridize with the related swordtails, yet although these two fishes live almost side by side in their natural habitat they have not been known to hybridize there. Careful study of this suggests that courtship is not only a way of bringing the sexes into breeding condition, but is also a kind of language by which members of the species recognize each other and also learn to tell the difference between their own kind and members of another species. The courtship of the platys and swordtails is very similar differing only in a number of small details. None of these is important on its own but together they keep members of the different species apart. In an aquarium, where there is not the same wide choice of partners the 'language' breaks down and a male and a female of different species will come together and breed, giving rise to hybrids.

Cancer research

From one such hybridization came a significant discovery of medical importance. When a spotted platy was crossed with a green swordtail the offspring always developed cancerous growths along the sides of the body, remarkably like certain types of cancer in human beings. Here was an example of an heritable cancer—one that could be produced to order merely by crossing two kinds of fishes. This made it possible to study the genetics of cancer in a species that bred rapidly so giving quick results. Comparable studies on humans would prove long and difficult.

class	**Osteichthyes**
order	**Atheriniformes**
family	**Poeciliidae**
genus & species	***Xiphophorus maculatus***

▽ *No colours barred. Through selective breeding platys have probably provided more colour varieties than any other aquarium fish.*

Michael Johns

Okapia

Platypus

Today the platypus is accepted as an unusual animal of quaint appearance, but it is not difficult to imagine its impact on the scientific world when it was first discovered. So strange did the creature appear that one scientist named it ***paradoxus,*** *and a paradox it was with duck-like bill, furry mammalian coat and webbed feet.*

Known as the duckbill, watermole or duckmole, the platypus is one of Australia's two egg-laying mammals, the other being the spiny anteater. The platypus is about 2 ft long including a 6in. beaver-like tail and weighs about 4½ lb, the males being slightly larger than the females. The 'bill' is a sensitive elongated snout and is soft, like doeskin, not horny as is popularly supposed.

Although bizarre in appearance, the platypus is well adapted to its semi-aquatic life. The legs are short with strong claws on the toes and the feet are webbed. The webbing on the forefeet extends well beyond the toes, but can be turned back when on land, leaving the claws free for walking and digging. The eye and the opening to the inner ear lie on each side of the head in a furrow which can be closed when the platypus submerges. There are no external ears, thus the platypus is blind and deaf when under water. Young have teeth, but these are replaced in the adult by horny ridges.

Thick loose skin makes the barrel-shaped body of the platypus appear larger than it is. The pelt consists of a dense woolly undercoat and long shiny guard hairs. The colour varies from sepia brown to almost black above and is silver, tinged with pink or yellow underneath; females can be identified by the more pronounced reddish tint of their fur. Adult males have hollow spurs, connected to venom glands, on the ankle of each hind limb. The poison from them can be quite harmful to a man, although not fatal.

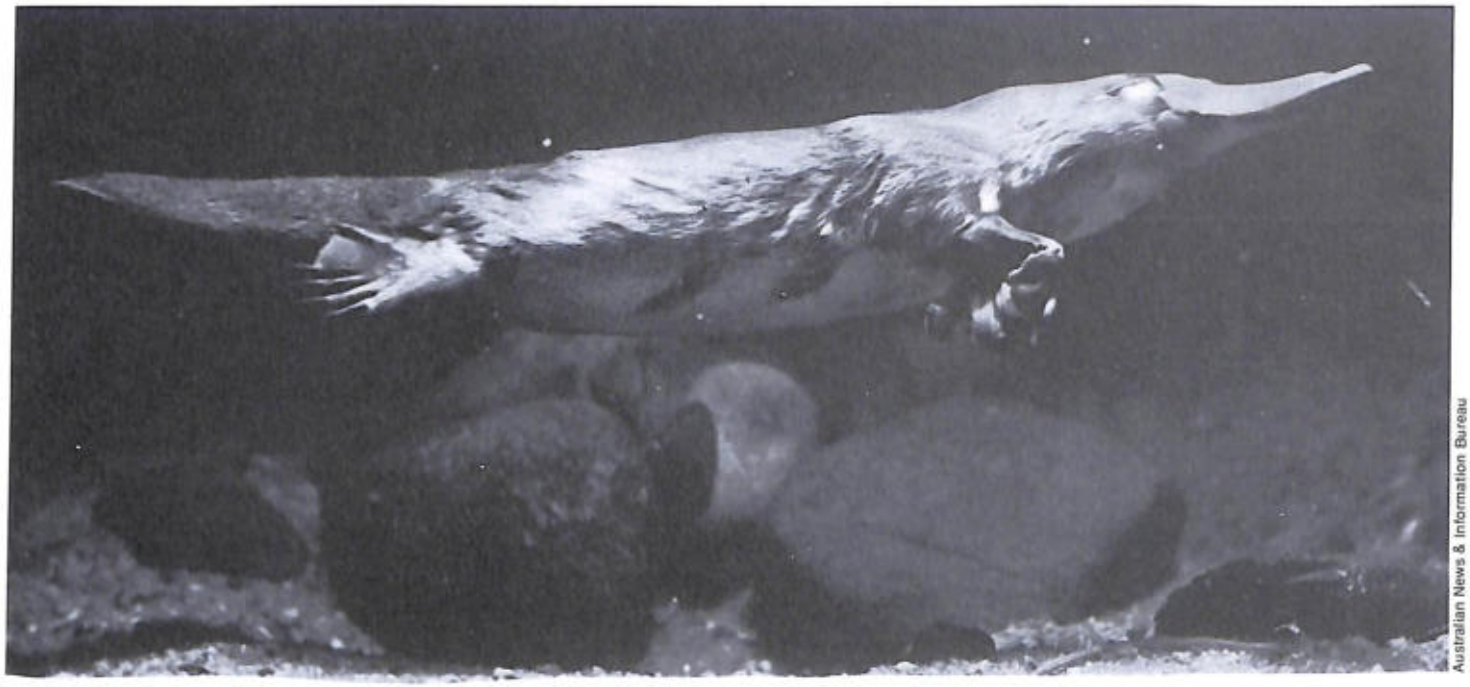
The platypus was not discovered until 1796, nearly 200 years after the first wallaby, for instance, had been seen by a European. This is not as strange as might appear at first sight, for aquatic animals tend to be elusive particularly if, like the platypus, they are nocturnal.

Its range can be seen on the map. The western limits are the Leichhardt River in North Queensland, and the Murray, Onkaparinga and Glenelg rivers, just within the border of South Australia. It is found in all fresh water, from clear icy streams at 5 000 ft to lakes and warm coastal rivers.

Australian News & Information Bureau

▷ *Platypus dives in a cloud of silvery bubbles. When underwater the platypus is blind and deaf so it relies mainly on its sense of touch, highly developed in the soft rubbery bill.*

◁ *Out of its front door and into the river.*



Australian News & Information Bureau

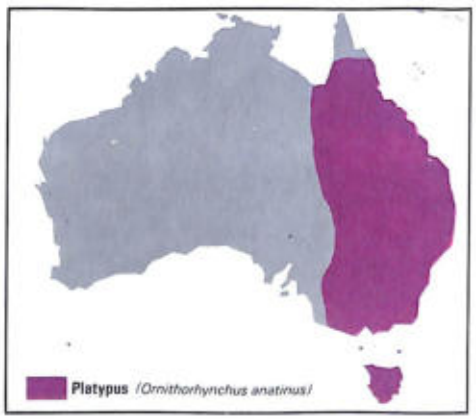
△ *In the water the platypus uses its strong webbed forefeet for swimming and its hind legs as rudders. On land its forefeet are used for digging and to press the water out of its fur before it enters its burrow.*

Hearty appetite

Like many small energetic animals the platypus has a voracious appetite, and probably needs more food, relative to its weight, than any other mammal. It feeds mainly in the early morning and late evening, on crayfish, worms and other small water animals. It probes for these with its bill and at the same time takes in mud and sand, which are apparently necessary for breaking up the food. During the day the platypus rests in burrows dug out of the banks, coming out at night to forage for food in the mud of the river-bottom.

Egg-laying mammal

The breeding season is from July to October and mating takes place in the water, after an elaborate and unusual courtship. Among other manoeuvres, the male will grasp the female's tail and the two will then swim slowly in circles. The female digs a winding, intricate burrow in a bank 25–35 ft, sometimes as much as 60 ft, long, 12–15 in. below the surface of the ground. At the end, a nesting chamber is excavated and lined with wet grass and leaves. The female carries these by wrapping her tail around a bundle. Usually two soft-shelled white eggs are laid, each ½ in. diameter. They often stick together, which prevents them rolling, and the wet leaves and grass keep them from drying out. Before retiring to lay her eggs, 2 weeks after mating, the female blocks the tunnel at intervals with earth, up to 8 in. thick, which she tamps into position with her tail. During the incubation period of 10–12 days she rarely leaves the nest but each time she does so these earth blocks are rebuilt. Presumably this is a defensive measure, but in fact today the platypus has virtually no natural enemies, although a carpet-snake or goanna may occasionally catch one. The inference is that in past ages natural enemies did exist in some numbers and the earth-block defences were very necessary. This is an example of what is known as 'fossil behaviour' and the platypus itself is a living fossil.



Use for spilt milk

The young platypus is naked and blind, and its eyes do not open for 11 weeks. It is weaned when nearly 4 months old, at which age it takes to the water. The mother has no teats; milk merely oozes through slits on her abdomen where it is licked up by the babies. A platypus matures at about 2½ years and has a life span of 10 years or more.

Competing with rabbits

Formerly hunted ruthlessly for its beaver-like pelt, the platypus is now rigidly protected. Too often, however, it falls foul of wire cages set under water for fish. Should the platypus enter one it cannot escape and will drown, as it is not able to stay under water for much more than 5 minutes. The introduced rabbit of Australia threatens the platypus in a different way. Where rabbits have driven too many tunnels the platypus cannot breed: it needs undisturbed soil for its breeding burrows. Fortunately, although reduced in numbers, it is now well protected by the Australian authorities and it is in no danger of extinction.

Creature of contrast

Fortunately for the sanity of naturalists, the paradoxical facts that the platypus, a mammal, laid eggs and suckled its young were not known when it was first discovered. In 1884, WH Caldwell, who had gone to Australia specially to study the platypus, dissected a female which had already laid one egg and was ready to lay another. Thrilled by this discovery he electrified members of the British Association for the Advancement of Science, then meeting in Montreal, with his laconic telegram – 'Monotremes oviparus, ovum meroblastic' (monotremes egg-laying, egg only partially divides). Delegates stood and cheered, for controversy over this point had raged in the scientific world for some years.

Long before this, in 1799, the first dried skin reached London and came into the hands of Dr Shaw, then assistant-keeper in the Natural History section of the British Museum. When Dr Shaw saw the skin he literally could not believe what he saw. At that time visitors to the Far East were bringing back fakes such as the 'eastern-mermaid', made from the skin of a monkey skilfully sewn to the tail of a fish. It is not surprising, therefore, that Dr Shaw should suspect someone had grafted the bill of a duck on to the body of a quadruped. He tried to prise off the bill, and today the marks of his scissors can still be seen on the original skin which is preserved in the British Museum (Natural History).

class	**Mammalia**
order	**Monotremata**
family	**Ornithorhynchidae**
genus & species	***Ornithorhynchus anatinus***

Plover

These pretty waders which can often be seen running rapidly along the foreshore, stopping for a moment and then running, are part of the large family of waders which includes the lapwings, dotterel and killdeer that have been treated separately. Attention is given here to the golden plovers ***Pluvialis*** *and sand plovers* ***Charadrius.***

The four species of golden plover are distinguished by spangled black and gold backs. Their underparts are usually black in the breeding season. At this time, the male golden plover, about 11 in. long, is spangled above and black below, with a white line separating the two that runs from above the base of the bill, over the eye and follows the margin of the wing. The female is very similar. In winter the black disappears and the underparts become white with some mottling. The golden plover lives in Iceland, Faeroes, the British Isles, parts of northern Europe and northeastern Siberia. The closely related American golden plover is smaller, 9½ in. long, but otherwise is similar to the European golden plover. It breeds in the Arctic regions of Canada, Alaska and Siberia. The grey plover, known in North America as the black-bellied plover, also breeds in the Arctic, but not in Greenland or Scandinavia. The breeding plumage of the male is silver, rather than gold-spangled. The fourth species is the so-called dotterel of New Zealand which has reddish-brown underparts.

The sand plovers are smaller, generally brown or grey above and white underneath with black bands across the breast and face. They include the ringed plover of northern Europe, together with the British Isles, northern Asia, Greenland, Iceland, Spitzbergen and parts of Arctic Canada. The little ringed plover is found over most of Europe, North Africa and Asia as far as Japan and New Guinea. The Kentish or snowy plover breeds in North America, the West Indies, Europe, many parts of Africa, Asia and Australia. It no longer breeds in Kent or anywhere else in the British Isles. The most unusual of the plovers is the wrybill of New Zealand. It is the only bird with a bill that is bent sideways.

Spangled male golden plover struts jauntily along in his attractive breeding plumage—a striking white line separates spangled top from black below.

Eric Hosking

Michel Brosselin: Jacana

Long migrations

Many plovers make long migrations to and from breeding grounds. One of the less spectacular is that of the wrybill, which breeds in South Island, New Zealand and winters in North Island. The American golden plover, however, travels from the high Arctic to Argentina and Australia and the grey plover, another Arctic breeder, winters in Chile, South Africa and Australia.

Plovers live on shores or very open country, usually near water, although the mountain plover of the dry plains of the southwest United States never lives near water. Outside the breeding season they gather in flocks to feed in estuaries, flying together with the precision often seen in flocks of waders.

More than it can chew

Plovers eat mainly small animals such as insects, worms and small molluscs. Occasionally one tries to tackle too much, for ringed plovers and others have been found caught with their bills between the shells of cockles. The wrybill uses its odd bill for probing under stones in search of insects. On migration the American golden plover eats large numbers of grasshoppers and locusts. Berries are also eaten, especially by the American golden plover. It lives on the previous year's berries when it arrives in the Arctic during spring, before the insects have appeared.

Careful guardians

Plovers' nests are usually no more than scrapes in the ground, without any lining. Many species regularly lay a clutch of 4 eggs but there may be as few as 2, as in the wrybill, or as many as 5. Both parents incubate and tend the young, who leave the nest shortly after hatching. The incubating period is about 4 weeks in larger species and 3 weeks in smaller species. The chicks fly in 3—5 weeks.

Plovers are very inconspicuous when not in a flock and can often be found only by searching for the source of their whistling calls. The nests are also very difficult to find

G Ruppell

Cockle shell nesting site: a Kentish plover about to settle on its mottled clutch.

and plovers regularly attempt to divert intruders by distraction displays in which they make themselves conspicuous. One display is the 'broken wing' in which one wing droops, showing up the white plumage underneath. In the 'rodent run' the plover runs with its tail drooping. The ringed plover, moreover, spreads its tail to show a conspicuous white border as it runs away from an intruder.

More about migrations

Usually if one is studying a bird's migration it is possible to go to one place to watch the movement both to and from the breeding grounds. If, however, one watched the American golden plover flying down through Labrador or New England it would be no use coming back to see them return in the autumn, for they return by a different route. The golden plovers travel south from Arctic Canada and Alaska across Hudson's Bay to Newfoundland and New England, then across the sea to South America. In spring they return through Central America and up the interior of North America. There is a reason for this circular tour; the plovers are taking the shortest route that allows adequate food on the way. In the autumn they travel to the Atlantic coast to gorge on berries before setting off on their long sea journey to South America. The return trip would be impossible in spring because this area would still be foggy and frost-bound, offering no comfort to the plovers after a non-stop ocean flight. The interior of the continent however, warms up quickly in spring and food will already be available.

Another interesting migration is made by the ringed plover. It has recently colonised Greenland, Ellesmere Island and Baffin Island. These populations do not migrate to South America, but cross to Iceland then follow their ancestors' trail down through Britain into Europe and West Africa.

class	**Aves**
order	**Charadriiformes**
family	**Charadriidae**
genera & species	***Anarhynchus frontalis*** *wrybill* ***Charadrius alexandrinus*** *Kentish plover* ***C. dubius*** *little ringed plover* ***C. hiaticula*** *ringed plover* ***C. montanus*** *mountain plover* ***Pluvialis apricaria*** *golden plover* ***P. dominica*** *American golden plover* ***P. squatarola*** *grey plover* ***P. obscurus*** *New Zealand dotterel, others*

◁ *Overleaf: Flock of grey plovers take to flight.*
▽ *Distraction: a Kentish plover feigns a broken wing in an attempt to divert the photographer's attention from a well-camouflaged nest.*

We-Ha

We-Ha

Fan dance: a long legged plume moth ***Pterophorus pentadactylus*** *looks rather ghost-like with its 'feathered' wings spread out at right angles to its body.*

Plume moth

The plume moths make up a comparatively small family whose wings are divided into 'feathers'. The forewings which are very long are divided into two or three parts and the hindwings into three or four parts. A few have wings without clefts, such as the European genus ***Agdistis****. The bodies of plume moths are very long and slender, as are the legs which have prominent spurs. The wingspan ranges from ¼–2 in. The flight is feeble and with their long body and legs, plume moths look rather like daddy-long-legs (p. 736). When at rest the forewings are rolled around the hindwings and usually held straight out at right angles to the body.*

There are about 600 species of plume moths, found in most parts of the world. Closely related are the feather-winged moths of the family Alucitidae, most of which are found in Asia. The many-plume moth, with ½ in. wingspan, is found in Europe and the temperate parts of North America. The fore- and hindwings are divided into six and look like a pair of feather fans.

A watery death

During the day a sudden glimpse may be caught of a disturbed plume moth as it flies out of a plant in which it has been resting. Usually plume moths are active only in the evening or at night. They make themselves very inconspicuous when at rest among the herbage or hedgerows. Adults of *Agdistis* hold their rolled wings pointing forward in a line with the body, so they resemble the dried grass on which they rest. This camouflage is improved by their blackish markings which look like moulds.

Plume moths live on a variety of food plants but are only occasionally pests. The grape vine plume of the United States attacks the sprouting leaves of vines but is not as serious a pest as *Exelastis atomosa* of India which burrows into pods and eats the growing peas. The pupa is later formed within the pod. The leaves and sometimes the flowers of a plant are the usual food of plume moth caterpillars. The caterpillars bore into the leaf and flower stems making them wither, or they bind the leaves into a rosette with silk strands so they are protected while they eat. The caterpillars of *Stenoptilia pneumonanthes*, which feed on marsh gentians, are sometimes drowned by rain when they feed in the cup-shaped flowers. The caterpillars of *Agdistis bennetii* are liable to suffer the same fate. They feed and hibernate on the leaves of sea lavender, where they are in danger of being inundated by high tides.

Mobile pupae

Eggs of plume moths are usually laid on the leaves of the food plants and the caterpillars feed on these leaves or flowers, or bore into the stems and buds. There are often two generations in one year, the second hibernating as caterpillars in stems of the food plants. The pupa is soft and hairy and hangs from a leaf or stem like the chrysalises of some butterflies. Some species weave a cocoon that is no more than a few strands of silk thrown around the body. The caterpillars of the triangle plume, which has black triangles on its forewings, hatch in June and feed on coltsfoot. The adults emerge and are on the wing from August to September then a second generation of caterpillars becomes active in September. They feed on the leaves of coltsfoot, before burrowing into the stems to hibernate. In the spring they feed on buds and flowers then pupate in the seed heads, binding the seeds with silk so they do not fall. The adults emerge in May.

The pupa of *Leioptilus lienigianus* jerks sharply if disturbed, perhaps startling a predator. That of *Platyptilia calodactyla* is also mobile. It often wriggles to the surface of its burrow in a leaf but retreats if disturbed. It is prevented from emerging too far by an anchor rope of silk attached to its hind end and the inside of the burrow.

Preying on the predator

Adults of *Trichoptilus paludum* can sometimes be seen during the day, flying over boggy heaths and moors. They lay their eggs on sundew, a peculiar bog plant that captures and devours insects. This habit is found in other bog plants and is probably related to the deficiency of nitrate in boggy soils. The deficiency is made up by breaking down protein in the insects' bodies. The upper surfaces of sundew leaves bear hairs surmounted by glands. When an insect lands on a leaf it is trapped in sticky secretions, the hairs of the plant bend towards it and secrete fluids that digest it. The products of digestion are then absorbed by the plant. The caterpillars of *Trichoptilus* feed on sundew leaves, and presumably in some way avoid being caught and digested, but it seems to be as precarious a way of life as living on man-eating tigers.

phylum	**Arthropoda**
class	**Insecta**
order	**Lepidoptera**
family	**Pterophoridae**
genera & species	***Orneodes hexadactyla*** *many-plume moth* ***Oxyptilus periscelidactylus*** *grapevine plume moth* ***Platyptilia gonodactyla*** *triangle plume moth, others*

Pochard

Pochards dive for their food, like grebes, with a quick jump up before plunging under. Thus they are more adapted to an aquatic life than their dabbling relatives, the mallard and pintail. Their legs are placed well back on the body and most pochards have difficulty in walking. They come ashore mainly for roosting and nesting. The short, heavy body has a large head and long neck. The males have an eclipse plumage when they live in the temperate zone. The three pochards in the genus ***Netta*** *are less adapted to an aquatic life and do not dive as well as the other species. They float higher in the water and walk more easily. The other 11 pochards are classed in the genus* ***Aythya****, of which there are four groups. The first of these includes the European pochard and the American canvasback and redhead. These are similar in plumage and important game birds. The second group is made up of pochards called white-eyes; the third group of pochards are mostly black and white, including the tufted duck and New Zealand scaup. The fourth group includes the tree scaups.*

The most important pochard is the canvasback that breeds in western North America from Alaska to New Mexico and migrates down the flyways (see pintail p. 1907) as far as South America. Even if it is not the most shot-at of ducks it is the most esteemed for eating. Most of the body is light grey with black on the breast, and a russet head and neck. A closely related pochard is 18 in. long and breeds in Europe and central Asia. The plumage of the two species is almost identical. Next in importance to these two is the redhead or American pochard. The tufted duck, 17 in. long, is an Old World bird, ranging from Iceland to Kamchatka. It is all black with very distinctive white flanks and a small trailing crest. The scaup duck, with a circumpolar Arctic distribution, has a plumage similar to the tufted ducks, but lacks the tuft and has a light grey back.

Most pochards live in the northern hemisphere but in the south there are the southern pochard from Ethiopia to South Africa, the New Zealand scaup and the Australian white-eye, which colonised New Zealand but later died out.

Roy A Harris & KR Duff

△ *Famous North American sporting duck, the canvasback, identified by reddish brown head.*
▷ *European tufted duck—the black and white male seen here has a thin drooping crest; the female is browner and has a rudimentary crest.*
▽ *Rosybill,* ***Netta peposaca****, like the other two of its genus, is a non-diving pochard.*

Roy A Harris & KR Duff

Commuting to feed

Pochards migrate in V-formation; sometimes the whole flock plunges spectacularly from a great height towards a sheet of water. Their habits are in general similar to those of dabbling ducks. Pochards breed in freshwater and some spend the winter in salt water or the brackish water of estuaries where they can be found in large flocks. Others only go to sea during very cold weather. There may be an excess of males in the flocks, as much as 50 to 1. They feed mainly in the morning and evening and sometimes at night. Shallower waters are preferred for feeding and in the evening there is a 'flight' from larger, and safer, waters to smaller pools. Pochards are awkward when they take off or land, as they have to run over the water before gaining sufficient lift with their short wings.

Serge Chevallier: Jacana

Tasty duck and celery

Pochards feed on aquatic plants and animals, usually diving to collect them from the bottom. The canvasback eats mainly plant food and for this reason its flesh tastes better than that of the European pochard which eats mainly small animals such as insects, molluscs, worms, small frogs and a few fish. About three-quarters of the canvasback's food is vegetable including water-lilies and wild oats. The best tasting canvasbacks are those that have fed on the 'wild celery' that grows around Chesapeake Bay. This has long ribbonlike leaves and grows just offshore in great quantities. The canvasbacks prefer the roots which taste like garden celery. They dive to uproot the plants and bite off the roots, leaving the rest to float away. Redhead and scaup also dive for water celery roots, but other ducks, such as the baldpate or American wigeon *Mareca americana*, and coots, wait for the canvasbacks to surface with a bill full of roots and then steal it from them.

Some pochards swim underwater with their wings, staying under for ½–1 minute or more. European pochards and tufted ducks prefer to feed in shallow water 2–6 ft deep, but scaups will feed in deep water.

Cuckoo duck

Pochards nest on marshes or lakes and ponds where there is abundant cover around the edges. Nests are often quite close together and are usually very near water. Canvasbacks and European pochards may nest among reeds in the water, raising the nest above the water level with a pile of dead reeds and other plants. The redhead sometimes lays its eggs in the nest of another duck, cuckoo-like, and the young are raised by foster parents. The female broods the 6–12 eggs, rarely leaving the nest for the 23–26 day period. The male usually leaves her before the chicks are hatched, although the male scaup sometimes stays with his family. The chicks are led from the nest as soon as they are dry, and guarded and fed by the female, who brings food to the surface for them before they have learnt to dive. The canvasback abandons her brood early, and these broods band together, forming groups of first year ducks.

E Thimm

E Thimm

Red-crested pochard nest. The nest is covered by the parents, hiding the eggs from predators and conserving some heat. This behaviour is seen in most ducks and some grebe species.

Making ducks precocious

The study of an animal's behaviour is often made by presenting a test animal with the different situations that it would normally meet when diving, feeding, courting, fighting and so on. From this the stimuli eliciting various forms of behaviour can be determined. A well-known example of this is the male robin attacking a bunch of red feathers, from which we learn that it is by the red breast that a robin recognises a rival. But the response to stimuli often varies and depends on other factors, such as the internal state of the animal. It has been found that some behaviour is controlled by hormones within the body (see phalarope p 1881.) When the testes and ovaries are not functioning sexual and aggressive behaviour are usually absent. Such behaviour can be stimulated by the injection of sex hormones and it has been found that the chicks of many birds may perform courtship displays when treated with these hormones. The male downy chicks of redheads start to perform courtship displays and calls after treatment with testosterone, the male sex hormone, as do male chicks of mallard and pintails. The displays given are, however, only those that appear in the adult 'spontaneously'. That is, they may be given when the male is not specifically courting. The treated chicks did not give displays that required the presence of a mate. This shows that courtship displays, like other forms of behaviour, are sometimes dependent only on the state of the animal, but at other times the animal also needs external signs or stimuli to trigger off the behaviour.

class	**Aves**
order	**Anseriformes**
family	**Anatidae**
genera & species	***Aythya americana*** *redhead* ***A. australis*** *Australian white-eye* ***A. ferina*** *European pochard* ***A. fuligula*** *tufted duck* ***A. marila*** *scaup* ***A. novae-seelandiae*** *New Zealand scaup* ***A. valisineria*** *canvasback* ***Netta erythophthalma*** *southern pochara, others*

Armada fleet of scaup ducklings tended by a female. The breeding grounds of this hardy duck are often within the Arctic circle.

Bel-G Vienne: Jacana

Pocket gopher

The name of these small hamster-like animals is derived from the two external furlined cheek pouches, which run from face to shoulder. They are used for carrying food and are turned inside out when they need cleaning.

There are 30 species of pocket gophers which vary considerably in size, with a body length from 3½ to 13 in. and tails from 1½ to 5½ in. The coat is usually thick and smooth, lighter and thinner on the underside. Pocket gophers living in hot lowland areas have shorter coarser fur. The fur colour varies from almost black through all shades of brown to off-white. Albinos are not uncommon. ***Macrogeomys*** *and* ***Zygogeomys*** *have characteristic white patches.*

The body is adapted for burrowing. The skull is large and angular, the body thickset and tapering towards the tail. Ears and eyes are small, the latter being kept moist with a thick fluid to keep the eyeball free from dirt. The legs are short and powerful, especially the forelegs, which have long digging claws. The tail is almost naked and is very sensitive to touch. By arching the tail to raise the tip just off the ground, a pocket gopher can feel its way as it moves rapidly backwards in its burrow.

All pocket gophers have long curving upper incisors, behind which the lips close to prevent earth entering the mouth while they are burrowing.

Peculiar to North America, pocket gophers are found from western Canada south to Panama. They do not travel far and are found in localised areas, often restricted to valleys by mountain barriers.

Popperfoto

Meston

Strong foreclaws (left) dig burrow, marked by fan-shaped mounds of earth at entrance (above).

The solitary burrower

These solitary rodents spend almost their entire life underground, only very occasionally coming to the surface to collect food. Each gopher lives within its own system of burrows and they only come together at mating times. Young pocket gophers can sometimes be found above ground after leaving their parents, and in drought or after floods adult pocket gophers may be driven out to look for new homes.

The individual burrows are often extensive and are marked by fan shaped mounds of earth around the entrances. These are carefully blocked with earth as protection against predators and to maintain suitable temperature and humidity. There are two types of tunnels: long, shallow ones, used mainly for getting food, and deep ones, used for shelter, with separate chambers for food storage, nesting and latrines. A great assortment of other animals use inhabited and abandoned gopher burrows.

Pocket gophers dig with their strong foreclaws, the curved incisors being used for loosening hard earth and rocks. The incisors are growing continually so replacing the worn surfaces. They may grow as much as 20 in. in one year.

Pocket gophers do not hibernate but may remain relatively inactive for long periods. Evidence of their winter activity is strikingly apparent when the snows melt in high pastures, revealing gopher burrows within the snow lined with earth, and left behind as a mass of criss-crossing 'cores' showing that the animals have burrowed at several levels. The tunnels are up to 40 ft long and 2–3 in. diameter.

Underground vegetarian

The staple diet of pocket gophers is tubers, bulbs and roots of plants which can be found and eaten in the security of the burrow. Occasionally at night, or on overcast days, pocket gophers surface in search of food, but more often plants are seen disappearing in jerks as, from the safety of its burrow, a pocket gopher pulls them down. In agricultural regions, crops often suffer badly as gophers favour sweet-potatoes, sugar cane, peas and fruit. Gophers never seem to drink, probably getting enough moisture from their plant food.

Little is known about the breeding and courtship of gophers, but if the soil and food conditions are suitable their numbers increase rapidly. A female may have one or more litters a year and the number of offspring varies considerably from 2 to 11. The newborn young, weighing about ½ oz, are blind and almost hairless. In most species they leave their mother at about 2 months to make their own burrow network. They are sexually mature within 3 months.

Safe underground

The best protection a pocket gopher has against its enemies is its underground way of life, but in fights with its own kind it is protected by the loose skin and thick hair around the head. Predators, such as coyotes, badgers and skunks, sometimes succeed in digging pocket gophers out and if they have to come above ground for any length of time owls and hawks make short work of them. Athough snakes and weasels hunt pocket gophers down their burrows, man is by far their worst enemy.

Pocket gophers can be very destructive, eating crops, burrowing through dykes and contributing to soil erosion. But on the credit side they do sterling work improving the soil by loosening, aerating and mixing it with organic matter. They also conserve water since, after a heavy snowfall, the melted water sinks deep into the earth through the maze of gopher tunnels instead of flowing straight into the nearest stream.

All manner of snares, traps, sling shots and spears are used to eliminate the pocket gophers and in Mexico the *tucero*, whose official job is to hunt pocket gophers, is a respected member of the village society.

Slim matriarchs

To allow manoeuvrability in tunnels a tapering body is essential, and burrowing animals generally have narrow hips. On the other hand, broad hips are an asset in giving birth. In virgin pocket gophers the pelvis is very narrow, with fused pelvic bones as in other mammals, leaving too small a gap for the passage of offspring during birth. Examination after birth shows, however, an enlarged opening which just allows an easy birth. Much of the bone of the pelvic region had been dissolved away through the action of hormones secreted during pregnancy.

class	**Mammalia**
order	**Rodentia**
family	**Geomyidae**
genera	***Geomys, Thomomys Pappogeomys, Cratogeomys Orthogeomys, Heterogeomys Macrogeomys, Zygogeomys***

Pointer

Pointers are one of the oldest breeds of sporting dog and can be seen in paintings dating from 1500. They were in existence in Spain and Italy before the 18th century, but did not become popular in England until early in the 18th century. Most historians of the breed believe that Pointers were introduced into England from Spain around 1700. The first specimens were probably brought back by officers of the British Army when they returned from Spain at the end of the Spanish war of succession. By the year 1800 the English sportsmen had worked on the raw material obtained to create the Pointer as it is known today–adapted, blended and vastly improved.

It is thought that this was done by selective breeding and not by crossing; and they created a dog of perfect symmetry which still thrives today.

E. Hendry; Tabby

△ *The Pointer is an extremely old gundog breed, which freezes into the characteristic 'point' when sighting game.*

Diane Pearce

▽ *This head study of a Pointer illustrates the 'dish face' so important in this breed. Note also the kindly, intelligent eye.*

The work of a Pointer

The Pointer is the very essence of fine game scenting. The most spectacular of the pointing breeds, it comes into its own in wide open country, such as a grouse moor, where the pointing of birds is of the utmost significance. The dogs are required to range well out, methodically quartering the ground in front of the guns. They carry head and neck outstretched when galloping. The higher the nose is presented to the wind the further off they will get the body scent of any birds in the area. Once they get the scent of a bird and its position they stop moving forward and point towards it with their heads held high, often standing with one foot lifted as in a freeze. At this stage the dog could easily be only a few yards from the bird, which will be apparently mesmerized by the dog's presence and remain perfectly still. The guns will now have moved up behind the dog and on a command from the handler the dog will move forward and flush the bird, which will fly up and present a target for the guns.

Pointers are quiet dogs and obey the slightest signals from their handlers. They must have plenty of stamina as a day's shooting on the moors means travelling great distances over heavy ground.

Perfect balance

The Pointer has great character. Its beautiful outline of graceful curves is most pleasing to the eye; it is a perfect adaptation of each part of the dog for the exercise of all its powers to the greatest advantage. Its head is distinctive, with a slightly 'dishfaced' appearance, round bright full eyes and a gentle expression with ears set high and close to the head, which when excited or on point, can be lifted and moved slightly forward. Its neck is long and muscular and the shoulders are long and sloping, running smoothly into the back. The chest is wide enough to give plenty of heart room but not too wide to hinder speed. The brisket is well let down to a level with the elbow. The ribs are big and it has a strongly jointed back bone. The croup is long and level with no sloping off, whilst the elbows are strong, muscular and parallel to enable them to just clear the body. The back of the elbows are placed directly under the withers, the strong forelegs have oval bones with long and rather sloping pasterns. The feet are oval in shape, and the hindquarters are long from hip bone to hock, the latter being flat, bony, clean cut and near to the ground. The thighs are well developed and muscular. The tail is carried straight, and is not too long, with thick bone at the root which gradually tapers to a fine point. In action the tail is lashed from side to side.

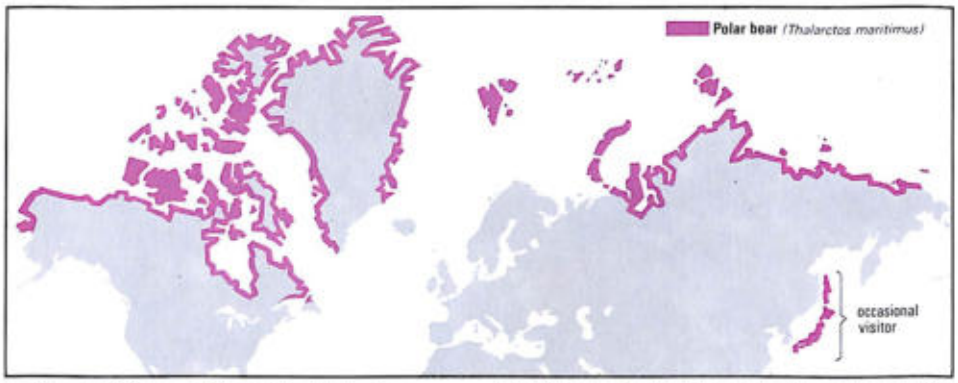
Exercise is essential

Although primarily a working dog, the Pointer is an adaptable animal and makes a good companion, but it must have access to large exercising areas where it can gallop freely without restriction. It must never be forgotten that Pointers are a galloping breed. They are full of energy and whilst young must gallop to develop a powerful, muscular body, strong legs and feet and free-moving, driving hindquarters. They cannot do this if confined to a small yard or run. However, providing they can have at least half an hour each day to gallop freely, plus longer galloping exercise two or three times a week, they will be quite happy. The usual colours are lemon/white, orange/white, black/white, liver/white. Self colours and tricolours are also correct. The desirable height is: dogs 25 to 27 inches; bitches 24 inches to 26 inches.

Polar bear

The polar bear is one of the largest and the most carnivorous of all bears. The males average 7—8 ft long and may reach 9 ft, with a height of 5 ft at the shoulder. The average weight is 900 lb and the maximum over half a ton. The females are smaller, with an average weight of 700 lb. Polar bears have a long head with small ears, and a 'Roman' nose, a long neck, powerful limbs, broad feet with hairy soles, and a mere stump of a tail. Their coat, white with a yellowish tinge, is made up of long guard hairs and a dense underfur.

Their home is along the southern edge of the Arctic pack ice. Although they can swim strongly, they avoid stretches of open water and fast ice. They are carried southwards by the ice in spring and summer and return northwards when the ice breaks up.



▷ *Overleaf: Queen of the castle. A polar bear isolated with her cubs keeps an eye open for intruders on the pack ice of the Arctic. The cubs remain with the mother unitl they are about two years old, and sometimes are allowed to cling to her as she swims along.*

▷▷ *Overleaf: A solitary polar bear steps carefully over the rocks of the Arctic. Polar bears roam for miles in search of food.*

▽ *A happy family – two cuddly cubs satisfy their hunger. Polar bear cubs stay with their mother until she is ready to mate again.*

Ruby Kellogg

A home of ice and water

Polar bears are expert divers and swim strongly, at about 6 mph, using only the front legs, and trailing the hindlegs. A thick layer of fat under the skin, 3 in. thick on the haunches, helps to keep them buoyant. Polar bears have been seen swimming strongly 200 miles from land. They usually swim with the head stretched forward, but when the sea is rough they put their heads underwater, lifting them periodically to breathe. The fat layer keeps out the cold. When it comes onto land the polar bear shakes itself like a dog.

Polar bears can walk easily over ice because of their hairy soles, and when pursued can run at speeds of up to 18 mph. They swing their heads from side to side as they walk, as if searching or smelling out prey. Essentially nomadic, they wander for miles in search of food.

Preying on seals

Their favourite food is seals, especially the ringed seal, which the bears stalk by taking advantage of snow hummocks. A seal asleep on the edge of the ice falls easy prey. The polar bear swims underwater to the spot, comes up beneath the seal and crushes its skull with one blow of the powerful forepaw. When a ringed seal is about to pup she digs an igloo in a hummock of snow over her breathing hole. Polar bears sniff out the igloos and take the pups. They are said also to hold down a pup with one paw so that its struggles attract the mother within reach of the bear. They will kill young walruses, but in a fight with a grown walrus the bear is likely to come off second best. The bears also eat fish, seabirds—at times their eggs, too—and carrion. A stranded whale will draw bears from a large area. Such a carcase once attracted 24 bears. At certain times of the year, usually in late spring or early summer, polar bears will eat large quantities of grass, lichens, seaweed, moss and other plants, and they are fond of crowberries, bilberries and cranberries.

Cubs driven away

Mating is in April or May and after a gestation of 240 days usually 2 cubs are born in December and January. At birth each cub is a foot long and weighs 1½ lb. It has a coat of short ‚sparse hair'. The eyes open at 33 days, the ears at 26 days, although hearing is imperfect until the cub is 69 days old. It starts to walk at about 47 days and is not weaned for 3 months. The cubs stay with the mother until they are at least 10 months old, often longer. When she is ready to mate again, she drives away any remaining cubs, which are by then 200—400 lb weight. Polar bears are sexually mature at 2½—5 years, the females maturing later than the males. Most of this detailed information, which would be difficult to collect in the wild, has come from records of successful breedings in zoos where some polar bears have lived well. Since polar bears are now being rapidly exterminated to satisfy the taste of the affluent for luxurious rugs it is as well that zoos have mastered the art of breeding these fierce but beautiful beasts.

No hibernation

It is often said that cubs are born while the mother is hibernating. Polar bears, like

Thor Larsen, WWF

AJ Southward

other bears, do not hibernate in the strict sense and it is now usual to speak of their sleep as winter dormancy. The pregnant she-bear seeks out a bank of snow in the lee of a hill and digs into it. There is difference of opinion as to whether the males 'hibernate'. It seems likely that some do, but for shorter periods than the females.

Man the enemy

Apart from man the polar bear has no enemies, if we except the walrus that may gore it in self-defence. Young bears die of accidents, by being drowned or crushed by ice during storms. Old males will kill and eat the cubs, given the opportunity. Polar bears have long been hunted by the Eskimos for their meat and their pelts. Their long canine teeth, too, are used for ornaments. Bed covers, sledge robes and trousers are made from the pelt. Although Eskimos eat the flesh the liver is not used, not even to feed the dogs. Its poisonous quality is said to be due to the high concentrations of vitamin A, which causes headaches and nausea, and sometimes a form of dermatitis.

Conserving the bear

CR Harrington, writing in *Canadian Audubon*, tells us that the earliest known record of polar bears taken into captivity was for 880 AD, when two cubs were taken from Iceland to Norway. 'At that time the animals were commonly offered to European rulers, who rewarded the donors on various occasions with ships carrying cargoes of timber or even bishoprics.' Intensive hunting of the bear began in the 17th century when whalers reached the pack ice. Two centuries later polar bears were decreasing in many parts of the Arctic. Then came the turn of the sealers, and in 1942 alone Norwegian sealers killed 714. More recently the Eskimos have been hunting the bears not for their own use but to trade the pelts. In parts of arctic North America it is easy to land by aeroplane and shoot the bears for sport, but legislation controlling this is under fairly constant review. In 1965 Harrington estimated the world population at over 10 000 with a total annual kill of about 1 300. In 1968 research scientists from five Arctic nations—the USSR, the USA, Canada, Norway and Denmark—established the Polar Bear Group to study life history, ecology, seasonal movements and population. Results have not been wholly published.

class	**Mammalia**
order	**Carnivora**
family	**Ursidae**
genus & species	***Thalarctos maritimus***

Taking the plunge. Protected by its thick layer of fat, a polar bear braves the cold waters of the Arctic where it may swim for miles out to sea.

Fred Bruemmer

Polar Environments

Many people think the polar regions are confined to the areas within the Arctic and Antarctic circles. But they are much more extensive than this, and although the Arctic and Antarctic have no physical boundaries, they may be set apart by different states of climate—which consequently affect animal and plant life.

The Arctic is commonly defined as those northern areas in which the mean temperature for the warmest month—or isotherm—does not exceed 10°C. This isotherm closely coincides with the northern limit of tree growth, ranging from 60°N in Greenland, Alaska and Labrador to 72°N in Siberia, although it may be surpassed by dwarf birch and willow scrub. The major part of the Arctic is ocean, encircled by the northern coasts and offshore islands of North America, Greenland and Eurasia; no land lies beyond 83°N. Because the sea tones down the climate, producing relatively warm but short summers, most of the snow disappears from the extensive undulating plains and valleys. Conditions are suitable for the luxuriant growth of the perennial herbs and dwarf heath shrubs and the ferns, mosses, liverworts, and lichens, which make up the typical short 'tundra' vegetation. The Arctic lowlands have an equally rich and varied fauna.

In contrast, the Antarctic is a far more inhospitable region. It is essentially a continent, some 5·5 million square miles in area, with a mean elevation of 6 000 ft and a permanent ice-cap containing 90% of the world's snow and ice, in places exceeding 10 000 ft in thickness. The continent is surrounded by 12 million square miles of perpetually cold ocean. The Antarctic is usually thought of as all land south of the 60° parallel, but it also includes the South Sandwich Islands and Bouvet Island as far north as 55°S in the South Atlantic, on account of their cold climate and consequent biological poverty. Climatically, the Antarctic is considerably colder, windier, and more arid than the Arctic. Summer temperatures in the interior rarely rise above −20°C/−3°F and only in certain lowland coastal areas—particularly the Antarctic Peninsula and nearby islands—do summer temperatures rise marginally above freezing point to melt the snow. These localities provide sparse habitats for plants and animals. Such forms of life that exist must be adapted to survive the extremely exacting conditions. Antarctic vegetation is dominated by lichens, a few species of which grow on rock faces only 237 miles from the South Pole while wetter and more sheltered northerly areas support locally extensive stands of moss and lichen tundra vegetation. The most striking botanical difference between the north and south polar lands is that while there are about 900 species of vascular green plants in the Arctic—one-tenth of which occur at 83°N—the Antarctic has only two. Neither grow beyond 68°S.

Contrast in animals

The Antarctic's severe environment and impoverished flora is reflected in the absence of terrestrial animal life. Natural selection has favoured only a small number of species, but those which have succeeded in adapting themselves exist in very large numbers, although virtually restricted to coastal habitats. The land fauna of the Antarctic contains a single bird species and a small number of invertebrates. On the other hand the Arctic has a wealth of mammal and bird species, although the cold-blooded reptiles and amphibians are not represented. Herds of herbivorous musk ox and caribou roam the tundra plains. Arctic and snowshoe hares and several species of lemming are preyed upon by ermine, weasels, and Arctic foxes, while all

R Lewis Smith

Musk Oxen Ovibus moschatus *are confined to the northenmost regions of Canada and Greenland.*

◁ *Many low-lying headlands of the Antarctic which might otherwise support plant life, with its attendant animals, are rendered unsuitable by vast colonies of penguins.*
▷ *Part of the Arctic's wealth of animal life: a snow-hare. The Antarctic has few animals because of its isolation from land masses caused by a vast and perpetually cold ocean.*

Popperfoto

animals live in fear of wolves. Land birds abound in the summer, ranging from numerous small birds (buntings, larks, pipits, wheatears, redpolls) to ptarmigan, ducks, geese and swans. They too fall victim to predators, including the snowy owl, peregrine and gyrfalcon.

Sea and shore birds are equally numerous, particularly gulls, ducks and waders, most of which are summer visitors. Although only 21 species of bird breed in the Antarctic, nine of which are petrels and six penguins, they are almost all highly gregarious in habit. Colonies of Adélie and chinstrap penguins may exceed a million inhabitants. In fact, many coastal habitats are rendered unsuitable for plant establishment by such densely populated colonies. Only the snow petrel is known to breed far inland. The only land bird, the sheathbill, scavenges along the shoreline and in penguin colonies whereas most other birds feed chiefly on small fish, crustacea and other marine life.

The largest of the true Antarctic land fauna is a tiny wingless fly *Belgica antarctica*, while several species of mites, ticks, and springtails, living among moss and under stones, complete the list of arthropods. The warm Arctic summer, however, brings forth swarms of flies, midges and mosquitoes, while beetles, bugs, bumblebees, butterflies and innumerable smaller species occur wherever there is lush vegetation.

Seas full of life

The polar seas are the most prolific in the world. They are unusually rich in chemical nutrients and plankton, the basic life form on which all marine food chains are dependent. Whereas in southern waters one group of fish, the nototheniids, is dominant, there are several important groups in the Arctic, including cod, herring and salmon. Fish and crustacea in turn provide food for the various species of seals, whales and seabirds. The scouring action of ice in the intertidal zone restricts marine vegetation to the deeper water where it provides habitats for a host of invertebrates.

The chief reasons for the differences in terrestrial life between the Arctic and Antarctic are fairly obvious. The Antarctic is essentially a high-altitude continent of ice, with an exceptionally cold and arid climate and separated from all other southern hemisphere land masses by a vast cold ocean. The fringe of the Arctic lands is either part of or close to the northern continents, most of which are low-lying and snow-free in summer except for the Greenland ice-cap and mountainous regions. So there is no barrier preventing plants and animals from migrating north to occupy the wide range of available habitats. The abundance of fossil plants and coal beds in Antarctica provides evidence of a warm climate some 250–50 million years before the Pleistocene glaciers changed the continent to its present state. Post-glacial immigration by plants and animals has been greatly restricted by geographical isolation from the southern continents, meagre habitats and the understandable inability to adapt to the severe conditions.

In the more northerly parts of the Antarctic elephant seals spend the summer on the beaches, basking and sleeping in the weak sun.

R Lewis Smith

roebild

Portrait of a polecat in its typical stance, long, slightly cylindrical body slung low, long neck stretched out and an inquisitive expression.

Polecat

The unpleasant discharge from its glands gave the polecat, or fitchew, its former English name of foumart or foul-marten. Because of this its fur, sold under the name 'fitch', is considered by some to be useless, but it was widely used in the early 19th century and is still used to a slight extent today.

The male polecat is about 20 in. long, of which about 5½ in. is bushy tail, and weighs up to 3 lb. The female is slightly smaller and only a little over half the weight. In both sexes the long coarse fur is dark brown on the upper parts with dense yellowish underfur showing through, and black on the underparts. The short legs and tail are black, as is the head, which has white or yellow patches between the small ears and eyes from June to November. These tend to join over the eyes in winter and, rarely, to join up with a chin patch. In a limited area of Cardiganshire, in Wales, a 'red' variety of polecat sometimes occurs, in which the coat is red, ginger or fox-coloured.

The polecat is still common throughout Europe as far north as southern Sweden and southern Finland. In the British Isles, however, it has become very rare except in Wales. Indeed, in mid-Wales, its numbers seem to be increasing.

Snake-in-the-grass

The polecat's long, almost cylindrical body moves at speed as it slinks across bare ground or close-cropped grass, with its body slung so low that it seems to be touching the ground. The long neck is stretched out and the short legs move almost in a paddling action, so the animal seems to glide rather than run. Seen from the side, the action of the limbs is more reminiscent of swimming than of running.

Taken young, polecats are easily tamed, and give little sign of their traditional smell, probably because this is used in the wild to mark a territory, not, as was formerly thought, as a defence. They also deposit urine and faeces along their trails to mark them. They spend a lot of time playing together; they will tumble over each other in a bunch, endlessly wrestling or romping—a mass of supple bodies. A significant part of this is that they grip each other by the back of the neck. This, it seems, is how they develop the neck bite used to kill their prey.

Versatile predator

A remarkable feature of the polecat is the great variety of habitats in which it can flourish. It is found in Wales from the coast right up into the hills, and is as much at home among sand dunes and on sea cliffs as it is about lowland farms or wooded gorges. It prefers, however, woods and copses, making its den in any suitable hole, such as a fox earth, rabbit burrow or natural rock crevice. A wood-stack has sometimes been used. With the approach of winter, polecats may seek shelter in deserted buildings. They are less agile than martens, and cannot climb as well as they do. They are active mainly at night, depending on a keen sense of smell to hunt down prey. They are usually silent but occasionally use short yelps, clucks and chatterings. They also scream and hiss when frightened, as part of a 'defensive threat'.

Kittens in the larder

The polecat feeds on rats, mice and rabbits, birds and their eggs, frogs, lizards and snakes. It is said to kill vipers and to be immune to their poison. The bodies of three kittens, known to have been drowned at least a quarter of a mile away, were once found in the larder of a polecat bitch. The usual method of carrying smaller prey is to grip it by the middle of the back, much as a retriever carries game.

It is usual, when speaking of polecats or any other small carnivore, to stress that they are adept at getting into hen-houses and that they have been known to kill all the occupants instead of just taking one. Indeed, the name is said to be from the French *poule chat*, the chicken cat. Accusations of poultry-killing may be justified to some extent. JG Wood, writing in 1852, said that the polecat was common in every part of England, but he also described it as 'dreadfully destructive to the poultry'. He tells of somebody's dog digging a polecat from its burrow and bringing out a whole brood of ducklings, previously lost by a farmer. Predators like the polecat, however, may help keep the populations of small mammals, especially rats and mice, within bounds. The wholesale reduction in the numbers of polecats might have contributed in the past to the calamitous increase in the populations of rats.

One litter only?

The polecat mates in early spring, probably in April, and the gestation period is about 6 weeks. Litters of 3—8, usually 5—6, are born in a nest of dry grass in woods or among rocks. The babies are blind for their first fortnight and are pure white, the colours and markings of the adults, appearing at about 3 months. It has been said that there is probably a second litter a few months later. This is unlikely since the young do not leave their parents until 3 months old, which would push the time of a second litter to late summer or early autumn. Baby polecats huddle in the nest to keep warm, but in hot weather lie as far from each other as possible. A female polecat in captivity was seen to wet her belly in her water-dish then curl herself around the babies to cool them. Another seemed to be teaching her babies to hunt. She would carry meat into the nest then drag it out, leaving a scent trail for them to follow to reach it. Whether this happens in the wild is not known.

Rapid extermination

According to L Harrison Matthews in *British Mammals*, the polecat was 'formerly a very common animal even close to London up to about a hundred years ago, whose rapid extermination over most of the country began with the first use of gin traps'. At the beginning of the 19th century it was still widely distributed throughout

England, Wales and Scotland, and records show that a total of 400 polecat pelts were sold at the old Fur Fair at Dumfries, in Scotland in 1829, and 600 in 1831. In 1866, however, the number of furs for sale at the fair was only six, after which they ceased to be included in the records. In parts of the Highlands the polecat survived longer and in Argyllshire was not uncommon about 1880. In the counties of Inverness, Ross and Sutherland it even survived into the present century but soon after 1907 the Scottish polecats seem to have become extinct and there has been no authentic record there in the past 50 years.

In England the polecat seems to have survived for as long or longer than in Scotland. Early this century it still lingered from Surrey westward to Cornwall, in woods in Lincolnshire, in several of the central counties, and in Cumberland.

Many years ago polecat-hunting was practised among the country squires of North Wales, Cheshire, Cumberland and Westmorland, where packs of hounds were kept specially for this.

class	**Mammalia**
order	**Carnivora**
family	**Mustelidae**
genus & species	***Mustela eversmannii*** *Asiatic polecat* ***M. putorius*** ***Vormela peregusna*** *marbled polecat*

▽ *Pigeon pie? Three young polecats tuck into a pigeon, savagely tearing it apart. They also enjoy duck and poultry, to the dismay of many a farmer, although they are good ratters.*

Roy A. Harris & KR Dutt

Pollack

The pollack is probably the most handsomely coloured member of the cod family. It can be recognized especially by the jutting lower jaw and the lack of a barbel on the chin. Otherwise its shape conforms to the typical cod pattern, with three dorsal and two anal fins, small pectoral fins, and very small pelvic fins lying under the throat. It is dark green on the back, shading to light green on the sides, which are streaked and spotted with yellow. The belly is white. The fins are dark yellowish green and the eye golden. The lateral line is dark and strongly curved over the pectoral fin. Pollack are up to 2 ft long, exceptionally 2½ ft, and the line-caught record is 23½ lb. They range from Norway to the Mediterranean.

The origins of the name are unknown, and it has been variously altered in the past to pollock, podlok and podley. The first of these names was taken to North America and given to the coalfish, (p. 590) the pollack's nearest relative.

Midwater feeders

Pollack are more a coastal fish than any other member of the cod family. They are often taken by line fisherman from the shore and when hooked they dive powerfully for refuge among the rocks. The pollack is not highly esteemed for its flesh, although it is regarded as a good sport fish. It is plentiful especially off Scotland where it is known as the lythe. Pollack come to the surface at night and are readily attracted by lights. Mackerel fishers often catch them with bright, moving baits. Their preference for moving bait gives a clue to their food. They feed in midwater on small fish, especially sand eels, sprats, herring and pilchard. They rarely stoop to feed on the bottom, on worms, crustaceans and molluscs.

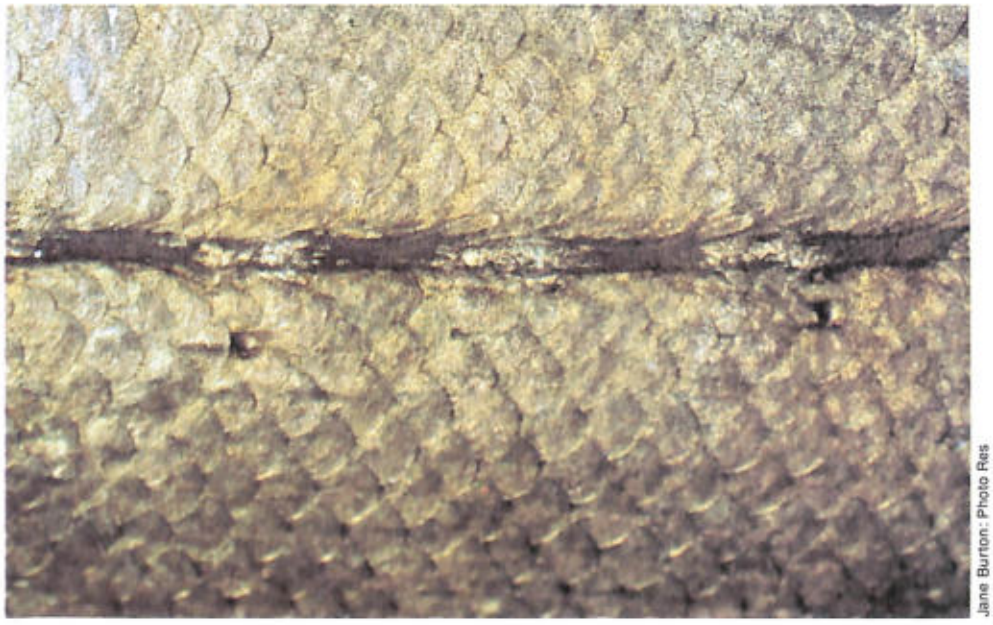
Junior marathons

Pollack spawn from February to May. The small, widely separated spawning grounds are in depths of 300 ft or less. Because the spawning grounds are so scattered—as far apart as the western English Channel and the Hebrides—young pollack make long migrations as they spread out around the coasts. The eggs, $\frac{1}{20}$ in. diameter, float near the surface. The young fish feed on the seabed, on crustaceans, worms and molluscs.

Delusory armour

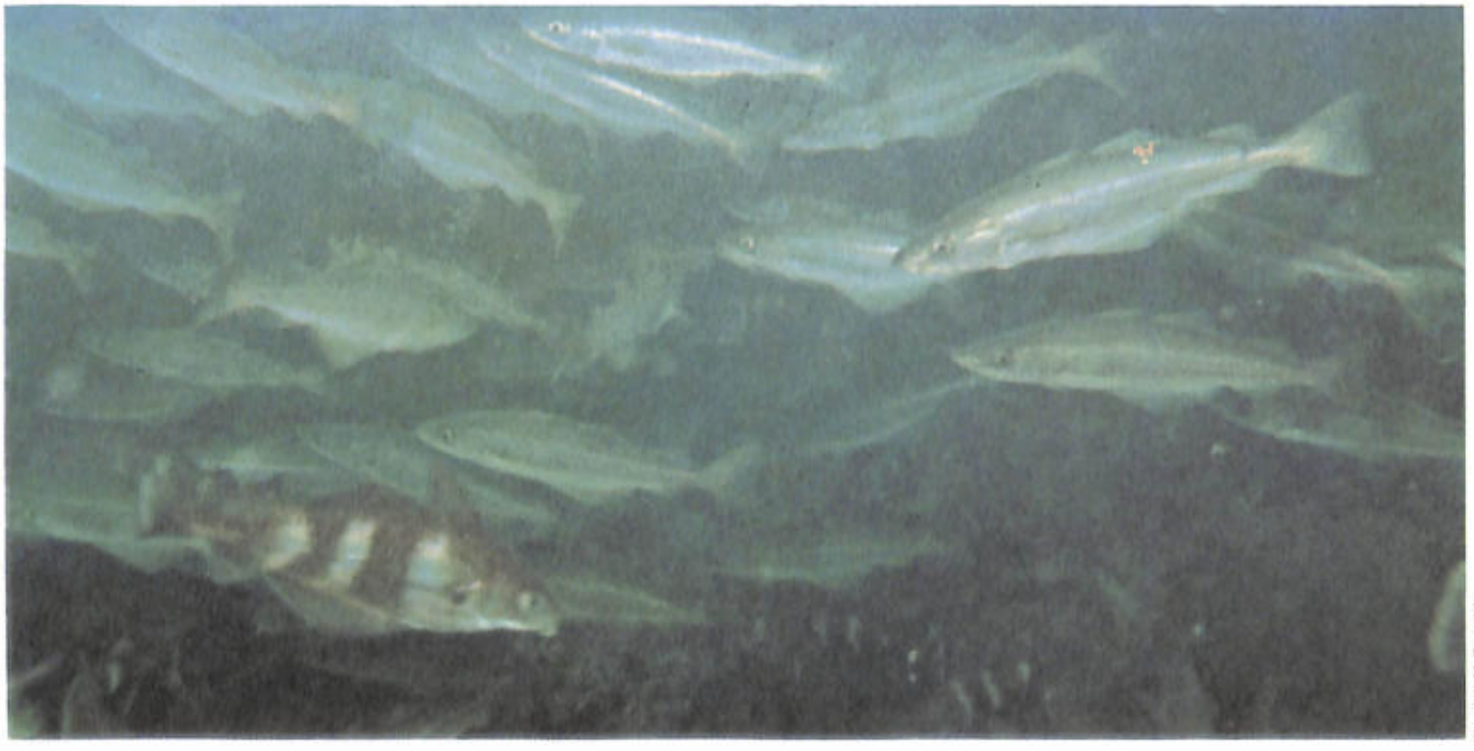
Many people regard scales as a protection, so it is worth noting a remark by Dr Douglas Wilson in his *Life of the Shore and Shallow Seas*. He points out that when catching pollack for the aquarium it is better to use hooks than a net and not to hold the fish in the hand when removing the hook: 'a torn jaw nearly always heals but a few lost scales generally end in death'. Shore fishes, more liable to be thrown about by waves, do not easily bruise. They usually have no scales or only tiny ones embedded in, or else firmly fixed to, the skin.

class	**Osteichthyes**
order	**Gadiformes**
family	**Gadidae**
genus & species	***Pollachius (Gadus) pollachius***

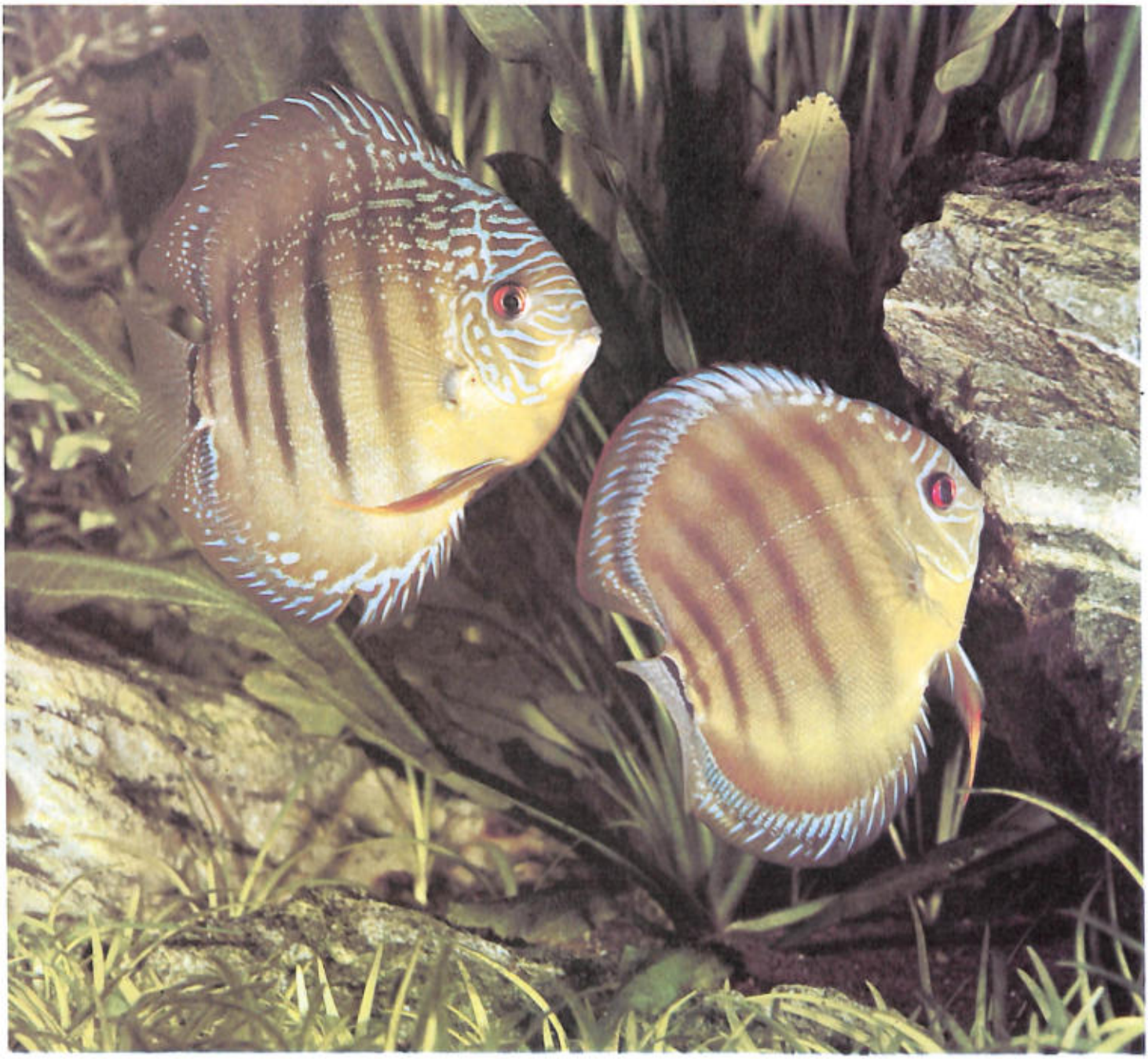


Jane Burton: Photo Res

◁ *The lateral line and tiny scales of pollack.*
▽ *Pollack, the most handsome member of the cod family swimming with bib* ***Trisopterus luscus.***



Kendall McDonald



Wolfgang Lummer

Pompadour fish

This fish from the rivers of the Amazon basin has been described as the noblest among aquarium fishes. Its name of pompadour is then quite appropriate although it is also known as the discus from its shape. The pompadour fish is divided into three subspecies known as the green discus, brown discus and blue discus, is almost disc-shaped when fully grown and up to 8 in. long. The long dorsal and anal fins make the otherwise oval body look more nearly circular. The body is covered with small scales but the cheeks and gill covers are more markedly scaly. The mouth is small, with thick lips. There is a single row of small conical teeth in the middle of each jaw and instead of the usual two pairs, there is a single pair of nostrils.

The colours are not easy to describe because they change with age. A young pompadour fish is brown with several vertical dark bars down each side. At 6 months old, flecks of blue appear on the head and gill covers, and these spread until the sides are coloured with alternating bands of blue and reddish brown and there are nine vertical dark bands, the first running through the eye. The fins become blue at their bases, pale blue and orange on the outer edges, and there are streaks of blue and orange between. The pelvic fins are red with orange tips. The green discus is mainly green with 9 dark vertical bars, the brown discus mainly brown with 9 dark bars and the blue discus brown with 9 blue bars.

△ *Turning blue with age, pompadour fish* ***Symphysodon aequifasciata****. At 6 months the head and gill covers become flecked with blue and this gradually spreads across the sides.*

Hanging by a thread

Pompadour fishes usually spend the day sheltering in the shadows of water plants when they are not feeding and they avoid strong sunlight. They eat water insects, especially the larvae of midges and small dragonflies, small worms and similar invertebrates. There is a brief courtship, during which the pair clean the surface of a broad leaf of a water plant. When this is ready, the female lays rows of eggs on it. Sometimes the surface of a stone is used but only after being meticulously cleaned. Once the eggs are laid the male swims over and fertilises them. The parents take it in turn to fan them with their fins and they hatch in about 50 hours. As each baby breaks out of

the egg it is removed in the parents' mouth and placed on a leaf, where each hangs by a short thread for the next 60 hours. The parents continue to fan with their fins and when, at the end of this time, the babies are about to swim, they swarm on the side of one of the parents and appear to hang there. After a time the parent gives a wriggle and the fry are shaken off towards the side of the other parent, who is swimming nearby. When 3–4 weeks old the fry become independent and feed on small animal plankton such as very small water fleas or their larvae. At first they are the normal fish shape, if a little plump in the body. The discoid shape comes with age.

Baby food in doubt

There can be little doubt that baby pompadours get protection by swarming on the side of the parent, although sometimes they are eaten by the parents, at least in aquaria. The question is whether they get something more. In 1959 Dr WH Hildeman reported observations that seemed to show that the babies fed on a slime secreted by the parents' skin. This seems to have been accepted by students of tropical fishes. In the 1969 edition of their book *All about tropical fish* Derek McInerny and Geoffry Gerard not only state that the parents secrete a whitish mucus over their bodies but that the fry will eat nothing else. They quote Mr R Skipper 'who has successfully raised several spawnings' and he claims they will not thrive on any alternative food. Indeed, he maintains the only hope of raising them is to leave them with their parents. Against this we have the words of Gunther Sterba, in his *Freshwater fishes of the world*, that not only do the young of some other cichlid fishes cling to the sides of their parents but that at least one aquarist has reared young pompadours away from their parents.

One reason why pompadours are not more often kept in aquaria is that young ones taken in the wild are infected with micro-organisms. The frequent changes of water necessary to keep them in captivity seem to favour the parasites, which kill the fish.

class	**Osteichthyes**
order	**Perciformes**
family	**Cichlidae**
genus & species	***Symphysodon aequifasciata*** *Pompadour fish* ***S. discus*** *common discus*

▽ *Discus fishes. The colour patterns of the two species vary a great deal and can be misleading.*

John Tashjian

Pond Life

Compared with the vast amount of research that has been carried out on lakes and rivers, surprisingly little attention has been given by professional scientists to ponds; but traditionally a pond is the amateur's happy hunting ground. At a conference of zoologists in Oxford some years ago a questionnaire was passed round among those attending, asking how and when their interest in biology started. This questionnaire revealed that the majority had been avid pond hunters in their schooldays. This is not surprising for no easily available habitat provides such a generous introduction to the animal kingdom as does a pond. In quite a small one there will be examples of most of the main phyla, or divisions, of animals: many kinds of protista, or single-celled organisms including such well-known members as *Amoeba*, *Paramecium* and the bell animalcule *Vorticella*; sponges; coelenterates, a largely marine group (sea anemones and jellyfish) but represented in freshwater by several species of *Hydra*; flatworms; threadworms; hair worms; annelids, or segmented worms, including the leeches; bryozoans or moss animals; rotifers; arthropods, including the crustaceans, insects and water spiders; molluscs, both bivalve and univalve; and, of course, the vertebrates, represented by the fish and amphibians.

A self-contained community

The usual definition of a pond is a small body of still water shallow enough for effective light to reach the bottom so it is possible for plants to grow all the way across. Shallowness rather than surface area is important. Vegetation is essential to most pond animals; apart from providing food for the herbivorous ones, it serves as shelter and as egg-laying platforms. The release of oxygen in photosynthesis is an important means of aeration in a stagnant body of water. Finally, when the plants die and are decomposed by bacteria, the ammonium salts, phosphates and other nutrients are brought back into circulation for re-use by other organisms. A shallow, weedy pond, therefore, is a highly productive system which can support a wide diversity of animals and plants as seen in the illustration opposite.

But apart from this variety and abundance of life, pond-living animals comprise an almost self-contained community which can be readily seen and studied. It is no accident that in school biology examinations a pond takes pride of place as an exercise in ecology, and valuable contributions to research can still be made by the amateur.

Adaptations for aquatic life

Perhaps the most fascinating aspect of pond life, once the various animals have been identified, is the way in which aquatic animals are adapted to live in water. None show this better than the aquatic insects. Because they are descended from terrestrial forms that took to the water, present-day aquatic insects show an astonishing diversity of modifications to enable them to survive in an alien environment. Beetles and bugs have beautifully streamlined bodies to enable them to move quickly in the water, which must be the envy of designers of marine craft. Their speed through the water is increased by flattened oar-like legs, fringed with stiff hairs which effectively add to their width. The common whirligig beetle goes even further: its legs are formed by a system of flat plates which present a broad surface on the swimming stroke, but fold like a fan on the return stroke, with much the same effect as an oarsman 'feathering' between strokes. Dragonfly nymphs can propel themselves through the water rapidly by a form of jet propulsion.

Breathing atmospheric air might be thought a problem for land animals that have adopted water as their permanent home rather late in their evolution, but with their typical versatility aquatic insects have devised a variety of ingenious and beautiful ways of obtaining their air: snorkel-like tubes for pushing just above the surface, as in the water scorpions, or air-bubble reservoirs for carrying about below the surface. Some of these reservoirs are more complex than was previously thought, as research in recent years has shown that some can absorb oxygen dissolved in the water and so act as a physical gill. Immature stages of insects can often take in oxygen through their shells, or by means of special thin-walled growths called tracheal gills. The present purpose of some of these—as in some mayflies—seems to be as paddles for creating a current of water to flow over the body and so bring fresh supplies of dissolved oxygen. The larvae and pupae of a small group of *Donacia* beetles even tap the supply of oxygen in the air spaces of submerged water plants.

A living classroom lost?

All these exciting aspects of life in freshwater, and many more, can be studied easily by anyone who lives within reach of a small body of water. Many schools are already using such ponds for biology studies; and anyone who does likewise in his own garden will have endless interest, not least in studying the incredible ways in which a new pond becomes colonized quite naturally and quickly in the summer with a wide variety of life.

Unfortunately this colonisation is part of a natural process which, left unchecked, will lead to the obliteration of the pond. Taking advantage of the new soil created by the decomposing remains of water plants, the encroaching pondside plants reduce the open water year by year until eventually the whole of the pond's area has been converted to dry land. Many ponds are also disappearing as a result of human activities, filled in with rubbish, or drained for agricultural purposes or building. Conservation measures such as controlled clearing of vegetation are needed to preserve this fascinating habitat.

John Clegg

◁ *Schoolchildren explore a pond in Oxfordshire, England. Every pond holds a wealth of animals representing most of the major phyla from protistans to vertebrates. All one needs is a simple net and some containers for the catch, and at once a fascinating new world is within reach. Ponds are not only for children; careful research into the relationships of the animals in them can still help our knowledge of ecology.*

On and among water plants

Diving beetles and larvae
Backswimmers (water boatmen)
Dragonfly nymphs
Mayfly nymphs (*Cloeon*)
Water spiders
Newts (during breeding season)
Pond snails
Hydra
Sessile rotifers
Bell animals (*Vorticella*)

Under floating leaves

China mark moth caterpillars
Bryozoa (*Plumatella*)
Planarian flatworms
Small leeches

On submerged rootlets of trees

Sponges
Moss animals

Swimming

Fish
Phantom larva, *Chaoborus*
Water fleas, *Daphnia*
Rotifers

Under the surface film

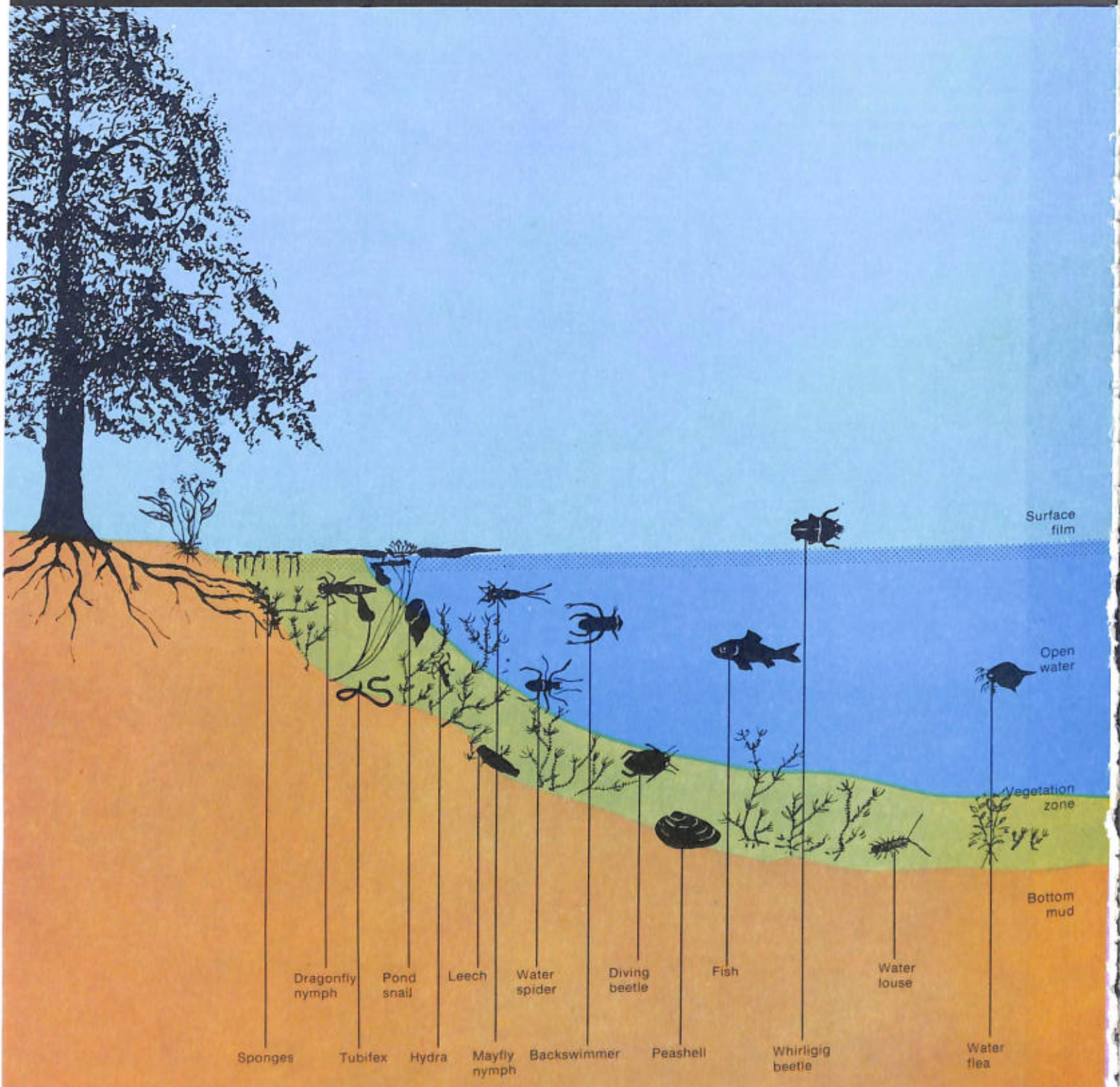
Gnat larvae and pupae

On surface

Water springtails (primitive insects)
Pond skaters
Water measurer
Whirligig beetle

In or on the mud

Protista (*Amoeba*, *Paramecium*)
Nematodes (threadworms)
Segmented worms (*Tubifex*)
Crustaceans (water louse and water flea)
Alder fly larva
Bloodworm larva of *Chironomus*
Lesser water boatman, *Corixa*
Bivalve molluscs (orb- and peashells)



Animal life in a pond is arranged in zones reflecting the different conditions in and on the water.

Legoni/Nielsen

1956

H Lou Gibson

Shadow and symmetry—even the pond skater's leg hairs make a beautiful pattern on the water. Overleaf: A perfectly balanced pond skater spreads its legs out on the glassy surface of the water.

John Clegg

Grappling iron? Pond skater's leg with water resistant hairs and a claw for catching prey.

Pond skater

Pond skaters, or water striders, are the familiar insects that can be seen floating or skimming swiftly over the surfaces of ponds, streams and flooded ditches. Their bodies are flat, narrow, and $\frac{1}{4}$—$\frac{3}{4}$ in. long. They appear to have only two pairs of legs, but the front pair are short and held close to the head, just behind the antennae. The rear two pairs are long and the tips are fringed with hairs, which rest on the surface of the water. Some species are wingless, others have small wings while a few have fully developed wings. Pond skaters develop through a series of moults from a small nymph. An adult bug can usually be distinguished from a nymph by its fully developed wings, but adult pond skaters are not so easily recognised because one with small wings could be a nymph or an adult, depending on the species.

While true pond skaters belong to the family Gerridae, other bugs that float on the surface of water are sometimes called pond skaters. These include the water measurer, or water gnat, family Hydrometridae, which has a curious long, narrow head and the water crickets of the family Veliidae. There are also the pondweed bugs of the family Mesoveliidae. One member is terrestrial, living among fallen leaves in the forests of New Guinea.

Running on water

Pond skaters often gather in groups along the edges of ponds and lakes, scuttling over the water when disturbed and then regrouping. They are propelled by the long pair of middle legs and steered by the hindlegs. When moving slowly, each flick of the legs sends the pond skater sliding several inches over the surface of the water, but they also hop across the water, rising an inch or so at each bound. Water plants present no obstacle and pond skaters walk over floating weed and even over dry water lily leaves.

Pond skaters prey on dead or dying insects which fall onto the water, grasping with their front legs and piercing the bodies of the prey with their mouthparts and sucking them dry. Cannibalism is common. Prey is detected by sight or by vibrations picked up by sense organs on the legs. One European species lives in estuaries and is also found around the coasts of the Baltic Sea. Pond skaters of the genus *Halobates* are among the very few marine insects. They live in tropical and subtropical seas, sometimes hundreds of miles from land, skimming over the waves and feeding on floating dead animals.

Adult hibernation

In temperate regions there are one or two generations of pond skaters each year, depending on the species. The second generation hibernates on land, but occasionally takes to water on warm winter days. In the spring and early summer they return to water and mate. About 100 eggs are laid in groups on submerged or floating plants and covered with mucilage. They hatch in about 2 weeks, depending on the water temperature, and a month later the nymphs finally change into adults.

Invisible support

The best time to watch pond skaters is on a sunny day. The tip of each leg can be seen to be in a dent in the water surface. If the water is shallow the shadows of the pond skaters can be seen on the bottom, and each leg is surrounded by a round shadow made by this dip. It is caused by the weight of the pond skater pressing the legs into the water, but it does not sink because the force of surface tension is counteracting this weight. The surface tension is due to a film of closely linked water molecules on the surface of the water which acts like a very fine rubber sheet. It is a very weak sheet and normally we do not notice it. It is this force of surface tension that holds a drop of water in a globule on a polished surface instead of spreading out in a film. The capacity of surface tension to keep objects afloat can be demonstrated by floating a cigarette paper in a glass of water and gently placing a needle on it. Eventually the paper becomes waterlogged and sinks, but the needle remains afloat—held up by surface tension.

Pond skaters sometimes enter the water completely but can refloat themselves because the undersides of their bodies are covered with a dense pile of hairs that traps air and prevents the body from becoming wetted. It has been said that a marine *Halobates* becomes wetted and drowned if a drop of rain lands on its back, but if this is so it is surprising that they have not been wiped out by tropical storms.

phylum	**Arthropoda**
class	**Insecta**
order	**Hemiptera**
family	**Gerridae**
genus & species	***Gerris lacustris*** ***G. thoracicus*** ***G. remigis*** *others*

Herman Eisenbeiss

Pond snail

To some people, any kind of freshwater snail is a pond snail, even if it lives more often in rivers. The name, however, is usually restricted to those snails with pointed spires and more or less oval mouths to their shells that make up the family Lymnaeidae. They are the commonest freshwater snails in both Europe and in North America.

Freshwater snails are of two main kinds. One group includes the river snails ***Viviparus*** *and valve snails* ***Valvata*** *which, with their marine relatives, can close the openings of their shell with a lid, or operculum. The others lack opercula, and are called Pulmonata because they have a lung, formed by the mantle cavity. The true pond snails, those we are dealing with here, belong to the second group, as do the bladder snails* ***Physa*** *and ramshorns or trumpet snails* ***Planorbis*** *and* ***Planorbarius****. These are called wheel snails in North America. In the true pond snails there is a lobe of tissue by the opening of the lung that forms a breathing tube, a kind of snorkel.*

One of the largest species is the great pond snail which grows to about 2 in. long, depending largely on the volume of water in which it has grown. At the other extreme, a full grown dwarf pond snail may reach only ¼ in. Unlike the shells of trumpet snails and bladder snails, those of pond snails are usually coiled to the right; the whorls increase in a clockwise direction as seen from the tip of the spire. In the ear pond snail the last whorl of the shell is greatly expanded, to give the whole an 'ear' shape, and this peculiarity is taken to an extreme in the bubble-thin shell of the glutinous snail. This species is unique in that the mantle tissue can spread outside the shell and all but cover it, so making the snail look like a little dab of glue. The shells of pond snails are generally a dark or pale horn colour and are carried with the spire directed backwards. The ear pond snail, however, points its spire to one side.

On the head are two non-retractile tentacles, each with an eye at the base, and in these respects the pond snails and other freshwater Pulmonata, known collectively as Basommatophora ('basal-eyed ones') contrast with the garden snail and other Stylommatophora ('stalk-eyed ones'). The latter have two pairs of tentacles which can be pulled into the body and the eyes are borne at the tips of the hindmost pair.

Heather Angel

An adaptable species, the wandering pond snail can live in a number of habitats, and survive long periods of drought. Unlike most pond snails it eats both plant and animal matter.

Not always in ponds

Pond snails creep along by waves of muscular contractions moving forward over the foot, and sometimes crawl upside down at the surface of the water. Some pond snails, like the great pond snail, crawl to the surface at intervals to renew the air in their lungs. If they cannot reach the surface, as when they are under ice, they accelerate their normal skin breathing. There are some species that depend entirely on the exchange of gases through the skin and have their 'lungs' permanently filled with water. Pond snails have also been known to survive being frozen in ice.

Pond snails live in a variety of freshwater habitats, though with the exception of the ubiquitous wandering snail, they do not colonise very soft or acid water. While some require large bodies of water, others, like the marsh snail and the dwarf pond snail, flourish in ditches or simply on wet mud, and can survive long periods of drought. A wandering snail has been known to survive 4 years in a dry aquarium, that had been stored away in an attic.

Cannibal snails

Some pond snails live mainly on scum-like algae and other plant material, which is why they are kept in aquaria, to keep the glass cleaned of algae. On the other hand, the great pond snail feeds on animal as well as plant matter and will even kill such lively animals as newts, sticklebacks and the larvae of water beetles. Some species will eat carrion or even resort to cannibalism. All rasp their food to tiny fragments with their file-like tongue, or radula, which is covered with thousands of teeth (see picture on page 12).

Mating chain reactions

Pond snails are hermaphrodite, each individual having male and female organs opening separately to the exterior. In the dwarf pond snail, a single individual fertilises itself. Tens of thousands have been reared in the laboratory without cross-fertilisation being seen. Usually one individual fertilises another, one taking the part of a male in every mating and the other taking the part of the female. Sometimes the one acting at that moment as a female acts simultaneously as the male to a third individual and in this way chains of mating snails may be built up. Reciprocal exchange of sperms between two snails is also possible.

Eggs are laid in gelatinous plates or cylinders attached to a firm support, with 2–100 eggs in each mass according to species and food supply. Development is rapid; in the dwarf pond snail young snails may emerge from the egg mass in 2 or 3 weeks and mature sexually within another 3 weeks.

What is a species?

To many people all pond snails must seem utterly insignificant and beneath notice. Yet, as host to the liver flukes, the dwarf pond snail has caused the deaths of millions of sheep (see fluke, p. 939). It is not strictly a water snail in that it flourishes on damp mud, feeding on the algae on the surface. A connection between liver rot and damp places was known for a long time but it was the discovery of the role of the snail that opened the door to effective control of the disease. Other water snails are hosts to other kinds of flukes, including human blood flukes. Each species of fluke is to some extent limited to particular snail species. Specifying the snails that support flukes is one of the main problems facing those who study the liver fluke. In Britain and many other countries, only the dwarf pond snail does so, but other species with similar habits may take its place elsewhere. Even in relation to the dwarf pond snail, however, the situation is not

clear cut. At one time the classification of pond snails was in considerable confusion, but even when a large number of species names were shown to refer to only minor variations in the individuals of one species, problems still remained. The difficulty is that there is not always a clear-cut distinction between one species and another—their origin by the gradual process of evolution prevents that. Moreover, populations of snails in different parts of the range of one species may differ in the extent to which they can carry flukes and yet the snails of these various populations may look alike to our eyes. Dr CA Wright, who is studying how to combat flukes, has devised various chemical tests to distinguish between populations of pond snails.

phylum	**Mollusca**
class	**Gastropoda**
order	**Pulmonata**
suborder	**Basommatophora**
family	**Lymnaeidae**
genera & species	***Lymnaea truncatula*** *dwarf pond snail* ***L. palustris*** *marsh pond snail* ***L. stagnalis*** *great pond snail* ***L. auricularia*** *ear pond snail* ***L. peregra*** *wandering pond snail* ***L. catascopium*** *N American pond snail* ***Myxas glutinosa*** *glutinous snail*

Heather Angel

△ *Glued on tight, the egg ropes of the great pond snail on the underside of pond weed.*
▽ *Great pond snails browse the algae which grow on plants, the side of the tank and on other snails.*

Walter J Murray NHPA

Poodle

Poodles reached a peak of popularity both in America and Britain early in the 1960s. In 1962 registrations in Britain were one and a half times greater than in any other breed. Entries at shows were phenomenal and puppy sales were so attractive that everyone jumped on the bandwagon so that the breed was nearly ruined by unscrupulous money-makers. No home was complete without its Poodle: Rufus, a brown Miniature Poodle, was the loved companion of Sir Winston Churchill.

Doubtful origin

The Poodle originated in Europe, indeed Spain, France, Germany and Russia would all like to claim him. A large, curly coated dog of obvious Poodle type was known all over the continent in the 1500s, although some would say that its origins date back to Roman times. Prince Rupert's white Poodle Boy, brought over from Europe and killed at the Battle of Marston Moor in 1644 is recorded in the British Museum. From then on there are records and pictures of this useful all-purpose hunting dog, which was particularly clever at retrieving from water, and was used as a gundog at duck shoots. Its thick, harsh, water-resistant coat was clipped roughly like the Portuguese water dog is today; the mane left on the shoulders and chest for warmth and protection, and the hind quarters shaved for freedom of movement and to prevent them from becoming water-logged. The Russian Poodle was still being used as a retriever until the middle of the 1800s.

The Standard Poodle had established its identity. Now a smaller type of Poodle was developed, which was the forerunner of the Miniature Poodle that we know today. These quickly became popular as ladies' pets; they retained the attributes and bright intelligence of their bigger brethren. In the 1930s Poodles began to be noticed by breeders and the public. In 1934 Mrs Sherman Hoyt drew attention to the breed when she imported a white Standard to America. This dog was International Champion Nunsoe Duc de la Terrace of Blakeen. He was a Swiss-bred dog, already a European and English Champion. His beauty, intelligence and wonderful character set the stage for an upsurge in Poodle popularity. A spectacular show career culminated with the first Best in Show ever won by a Poodle at the great Westminster Show. This was repeated many generations later by a line-bred descendent, Puttencove Promise.

Development

Two sizes of Poodle were recognized, the Miniature, under 15 inches at the shoulder, and the Standard, over this height. Meanwhile breeders began the attempt to produce a smaller size, and the Toy Poodle was evolved. These tinies became popular and American breeders set about breeding programmes to fix the Toys at under 10 inches. The British were more cautious and set their target at under 11 inches. In 1957 the British Kennel Club recognized the Toy Poodle as a separate variety. Now there are three sizes of Poodle, with the recognized measurements in America and Britain somewhat different from those in Europe.

Colour

All Poodles must be of whole colour. At first only black, white and brown were acceptable. American and British breeders extended this range to include the beautiful silvers, blues and apricots. These colours have only been recognized in Europe more recently.

Children's playmate

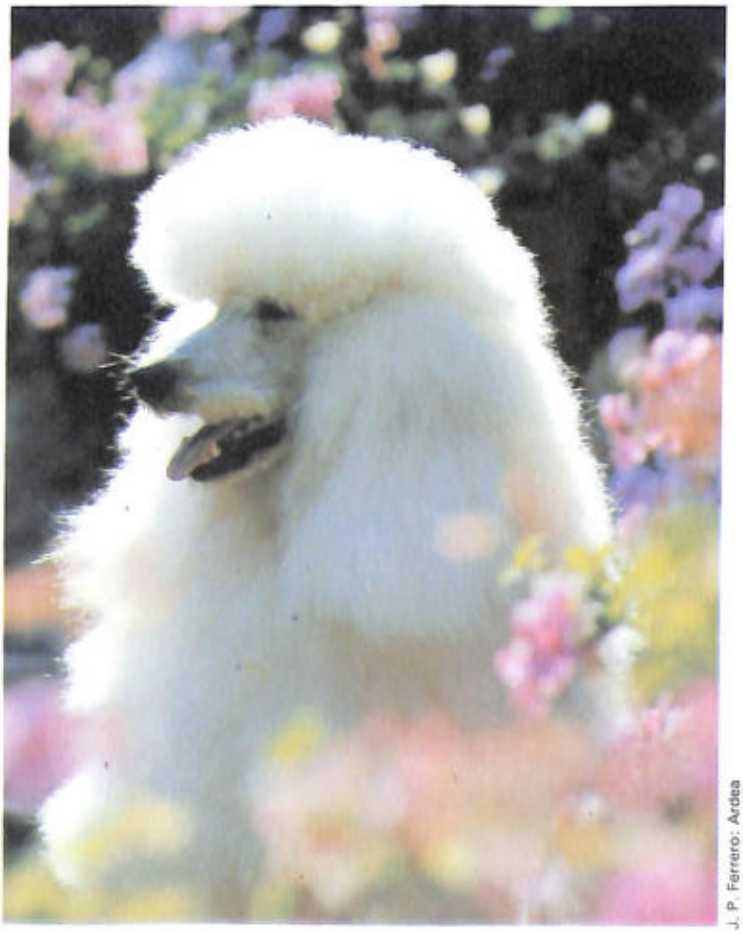
Now fixed in type and personality, the Poodle remains at the top in the show ring and can also excel in obedience. Obedience Champion Ant-on of Eyot C.D.Ex. won his way to fame in 1957. In America Miss Blanche Saunders trained the beautiful Carillon Standard Poodles to success in this field.

In spite of its popularity, in spite of the slight alterations in its appearance made by breeders, and in spite of its confinement in flats, and its place as the family pet, the Poodle has never lost its lively intelligence, its loving loyalty, and above all its astonishing adaptability. It will be a fireside pet and sleep on the bed, it will rough it out of doors, and is easily trained to the gun. It will even herd sheep and take part in mountain rescue. It loves children and will make an ideal playmate. It enjoys dog shows, and will readily jump on to the grooming table, well knowing that several hours bathing, drying, brushing, combing and scissoring are ahead of it before it is crated for a long journey. Once at the show it is prepared to give a sparkling performance, obviously enjoying its short-lived moment in the limelight.

Silver Poodles are more unusual than the blacks and whites.

Diane Pearce

There is nothing lovelier than a well-groomed Poodle.



J. P. Ferrero: Ardea

L Lee Rue III: Photo Res

Excellent camouflage no longer helps to hide a whip-poor-will as the photographer approaches —now a defensive threat posture is used.

Poor-will

This is the first bird that has been proved to hibernate. It is a nightjar, 8 in. long with the inconspicuous brown plumage typical of nightjars. The back is mottled and the underparts barred. The throat is white bordered with black and the short tail is white-tipped. The short wide bill has a very big gape, and is surrounded by long bristles. The eyes are large. It looks like the whip-poor-will shown except for smaller size and less white in the tail.

Poor-wills live in western North America, from southern Canada to Mexico.

Heat resistant birds

Unlike most other nightjars the poor-will is not confined to woodlands, but is also found on prairies and in arid country whose only cover is scattered sagebrush. It is even found in such hot places as Death Valley in California. It keeps cool at temperatures above 38° C by panting, so losing heat by evaporation from its respiratory passage. Poor-wills are better able to withstand high temperatures than many birds and mammals because they have a very low basal metabolic rate—the speed of body processes when at rest. Therefore the body does not produce much heat when the poor-will is inactive, so less of a strain is placed on the heat controlling mechanisms, like panting.

Poor-wills are nocturnal, roosting inconspicuously by day on rocks or branches and becoming active at dusk when they can be seen flying low over roads like giant moths. They are more often heard than seen, for they call on and off throughout the night especially in spring and late summer. The poor-will gets its name from this monotonous and persistent two-note call. At close quarters a third note can be heard and the call can be rendered as *poor-will-low*. Two other North American nightjars are named after their calls: the whip-poor-will and the chuck-will's-widow. The calls are the avian equivalent of the persistent nocturnal buzzing of cicadas and crickets. The record for continuity appears to be held by a whip-poor-will that called 1 088 times in succession.

Night hunter

Poor-wills catch nocturnal insects such as moths, beetles and bugs as they fly, scooping them up in the trap formed by the wide open bill and its surrounding bristles. The hard parts of the insects' bodies are ejected as pellets. Poor-wills hunt nearer the ground than other nightjars and sometimes search for insects on the ground.

Snakelike hiss

Poor-wills nest in May and June. The two eggs appear white but on close inspection are cream with a pinkish tint. They are laid in a shallow scrape in the earth or on bare rock or shingle, sometimes in the open but more often under a bush. The parents probably share incubation. They sit so tightly on the eggs, it is sometimes possible to handle them on the nest. Sitting poor-wills are very difficult to find as their mottled brown plumage blends in with the background, but if disturbed they utter a very snakelike hiss that may deter predators, or raise the wings high above the back.

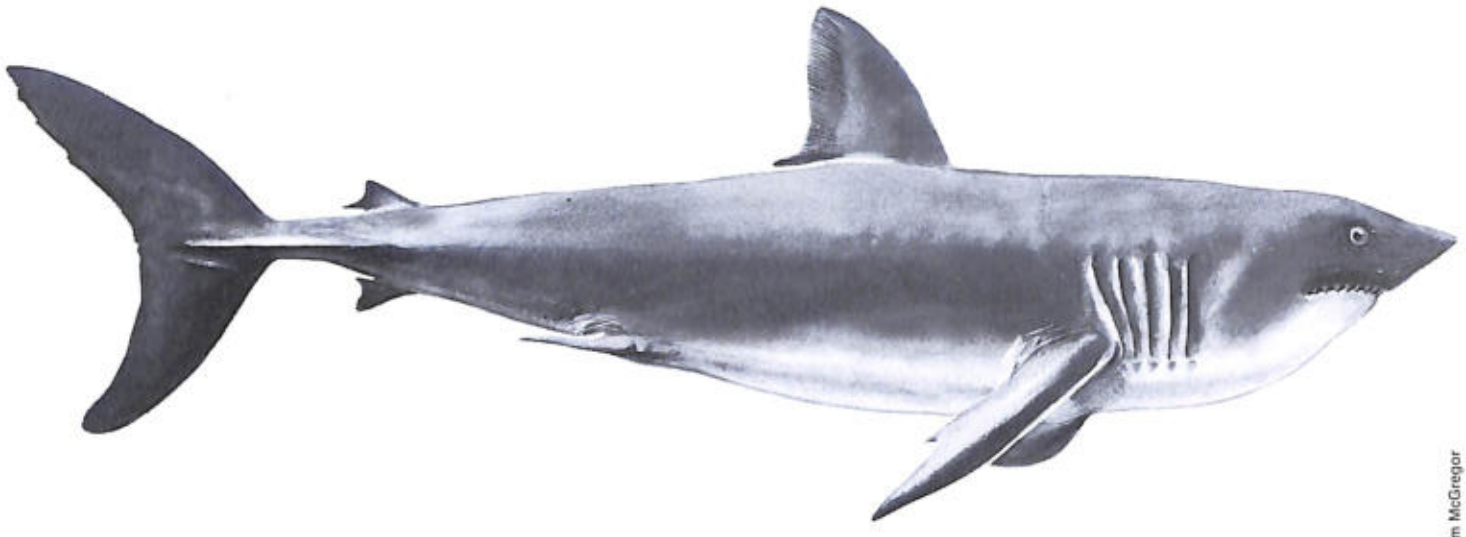
Poor-wills hibernate

For 2 000 years it has been suggested that some birds hibernate and it was even suggested that swallows spent the winter at the bottoms of ponds. Once it was shown, however, that the birds which disappeared at the end of summer had migrated to warmer countries, the idea of birds hibernating was discredited. Yet it was discovered that hummingbirds became torpid at night and nestling swifts became torpid when bad weather prevented their parents from feeding them. Temporary torpidity is not the same as true hibernation and proof that birds hibernate only came in 1946 when EC Jaeger discovered a hibernating poor-will in the Chuckawalla Mountains of the Colorado Desert.

The Hopi Indians were apparently well aware that poor-wills could hibernate for they call it the sleeping one, yet there are only two well-documented reports of hibernating poor-wills. This may partly be due to the extreme difficulty of finding them. Jaeger found his poor-will by sheer chance in a small depression in a granite wall. At first it showed no sign of life, but as it was replaced in its depression it lazily opened one eye and shut it again. Two days later Jaeger returned to find the poor-will in exactly the same position. He could not detect any heartbeat or breathing and the poor-will's body temperature was 18°C/64°F, 4.4°C/40°F lower than normal. A numbered ring was placed on the poor-will's leg and for four successive winters Jaeger found it in the same rock depression. Hibernation in birds had been proved.

Although only two hibernating poor-wills have been found in the wild they have been induced to hibernate in captivity. They become torpid when the air temperature drops to 3.5°C/38°F and the rate of oxygen consumption, an indication of the metabolic rate, drops to $\frac{1}{30}$ of the normal at rest. It has been shown that about $\frac{1}{4}$ oz of fat is sufficient to sustain a hibernating poor-will for 100 days, long enough to tide it over the winter dearth of insects.

class	**Aves**
order	**Caprimulgiformes**
family	**Caprimulgidae**
genus & species	***Caprimulgus vociferus*** *whip-poor-will*
	Phalaenoptilus nuttallii *poor-will*



Malcolm McGregor

Porbeagle

This shark, up to 12 ft long, but usually only 6 ft, lives in the Atlantic, as far north as Scotland and Iceland in the east and New Jersey in the west. Its name is said to be a combination of porpoise, from its general appearance, and beagle, from the way it hunts.

The porbeagle is plump and full-bodied but tapers sharply towards the tailfin, which is shaped like a new moon but with the upper lobe larger than the lower. The back is dark blue-grey, the belly white. The snout is sharply pointed and overhangs a large crescentic mouth in which the jaws are armed with 3 or 4 rows of slender awl-like teeth with small cusps at the bases. The lower teeth are directed upwards or slightly backwards. The gill slits are large, the spiracles small. The pectorals and the first dorsal fin are large, the second dorsal, pelvics and anal fins are small. There is a main and a secondary keel on either side of the tail.

There has been confusion in the past between the porbeagle and the mako, a larger shark, up to 13 ft, with a weight of 1 200 lb, more slender in the body and with a longer more pointed snout. Its teeth have no small cusps. It ranges through the whole Atlantic Ocean.

The North Pacific counterpart of the porbeagle is the salmon shark, which differs in the dark blotches on its underside. The Indo-Pacific mako is very like the Atlantic mako and may even represent the same species. It extends as far south as New Zealand. The sharp-nosed mackerel shark ranges from Cape Cod to the West Indies and there is the possibility that it sometimes comes into the eastern Atlantic.

△ *The porbeagle or common Atlantic mackerel shark can be distinguished from the other members of the mackerel shark family by having two instead of one stabilising keel on either side of the tail. The main keel is in the same lateral position as in the mako and the man-eater but there is also a small keel just below this but limited to the tail. It can also be distinguished by its teeth which point upwards and slightly backwards and are smooth and slender, unlike those of the maneater.*

Chewing small boats

The porbeagle and the mako shark are aggressive and dangerous to man, the mako more especially, and this is also given to attacking small boats, leaving its teeth behind in the timbers. Indeed, the mako more than any other fish has the reputation for doing this. Yet there are no records of it having attacked bathers in the Atlantic and very few elsewhere, probably because it does not come close enough inshore.

There has been so much confusion, with makos being called porbeagles and vice versa, that such notes as there are on the habits tend to have little value. We can speak on these in only general terms. Both oceanic, the porbeagle is often seen near coastal waters.

The only information about the breeding is that the females give birth to live young, as shown by captured sharks being opened up and found to contain four or more young, 2½ ft long and up to 20 lb weight.

Swift hunters

The food of a porbeagle is mainly fishes. In the North Atlantic they take herring, cod, whiting, hake, mackerel and dogfish. They also eat squid. The reputation of the North Pacific porbeagle is no better, judging by its common name. The mako will overtake the swordfish which has been credited with speeds of up to 60 mph, either biting off its tail or swallowing the whole fish in one gulp. One record is of a 730lb mako with a 120lb swordfish in its stomach.

Sporting nuisance

Porbeagles are not normally used for food and those caught are either thrown back into the sea or used as manure. The oil from their liver has sometimes been used, a 9ft shark yielding up to 11 gallons of oil, and in New Zealand the Maoris once used the teeth as personal ornaments, worn especially in the ears. The deepsea angler finds they give good sport, being swift and strong, the mako being especially famous for its leaps. The fisherman, on the other hand, has long suffered from their nuisance value. They sometimes get wrapped in drift-nets at the surface and they get mixed up in salmon and mackerel nets. People who have seen the sharks well out at sea speak of their 'dashing madly about' in pursuit of fish, and they probably attack fish in nets with the same crazed vigour, wrapping themselves up in an inextricable mass of twine. The long-line fisherman is not spared either since porbeagles and makos feed near the bottom as well. They snap the fish on the hooks on long lines and in the early years of this century a shark, porbeagle or mako, was taken from cod nets in the Firth of Forth, in Scotland. It had already been at the long lines somewhere else because in its stomach were 11 hooks with their snoods. One can picture it having swum along a long line snapping one hooked fish after another as it went.

class	**Chondrichthyes**
order	**Lamniformes**
family	**Isuridae**
genera & species	***Isurus glauca*** *Indo-Pacific mako* ***I. oxyrinchus*** *Atlantic mako* ***Lamna ditropis*** *salmon shark* ***L. nasus*** *porbeagle* ***L. tigris*** *sharp-nosed mackerel shark*

Porcupine fish

When relaxed the porcupine fish has much the shape of an ordinary fish, but when it blows itself up its body becomes almost spherical with long spines bristling all over it. Its tail and mouth look very small compared with this greatly distended body. It has large eyes, and the dorsal, anal and pectoral fins are of moderate size. Porcupine fish are about 1 ft long but may be as much as 2½ ft. In the same family are the burrfishes which have short spines that are always erect.

Doubly armoured

When disturbed or alarmed, porcupine fish inflate their bodies by drawing in water. The body swells, and the spines, which have been lying flat, are erected, standing out almost at right angles to the surface. If a porcupine fish is taken out of water suddenly it blows itself up by drawing in air. The spines, which may be 2 in. or more long, are sharp and anyone handling an inflated porcupine fish should wear gloves. Each of the long stout spines has a three-armed base, the paired arms of which overlap in the skin with those of their fellows, providing a more or less continuous 'coat of mail'. In some species the spines have only two arms at the base and can be raised and lowered without the fish inflating itself.

Porcupine fish which live in tropical seas, are slow swimmers; they swim by waving the dorsal and anal fins, helped to a small extent by the pectorals, the tailfin being used for steering.

Eating hard tack

The teeth of the porcupine fish form a continuous plate in the upper jaw with another plate in the lower jaw. Each plate has a sharp edge with a crushing surface behind it. The fishes feed by crushing molluscs and by biting off and crushing pieces of coral. The flesh of the coral is digested in the stomach. The stony matter in the coral, crushed by the dental plates, accumulates and one porcupine fish dissected had over 1 lb of crushed coral rock in its stomach.

The shark's dilemma

Nothing is known of the breeding habits or the enemies of porcupine fish. There are very few records of what happens when they are attacked but Dr William Beebe, distinguished American marine zoologist, watched some porcupine fishes threatened by a 4ft garfish bunch together for protection. They looked like one large round prickly fish. Then, for no obvious reason, from time to time one would leave the mass and swim away, to be promptly seized and eaten by the garfish. By contrast with this, Robert Hegner, in his *Parade of the Animal Kingdom*, takes the view that if a shark is foolish enough to swallow a porcupine fish it will pay dearly for it. According to him, when the prickly fish reaches the shark's

▽ *Submarine satellite. Free-swimming porcupine fish* ***Diodon hystrix*** *blown up with water.*

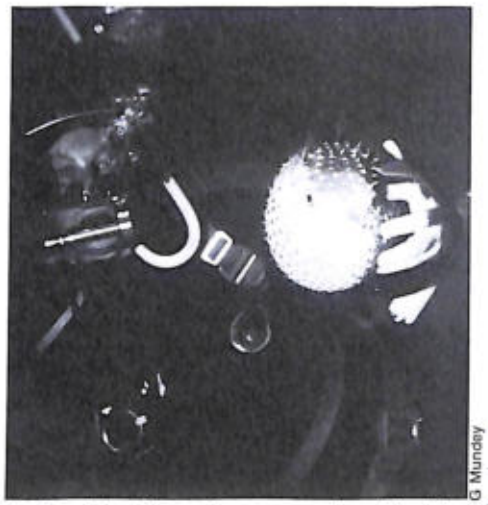
Peter Hill

stomach it gives out what Darwin called a 'most beautiful carmine-red fibrous matter', which is supposed to protect the fish from the shark's digestive juices. Thus protected it starts to cut and crush the wall of the shark's stomach and body wall until it reaches the sea and freedom.

Sharks have been seen to swallow these fishes but we can only surmise what happens inside them. Craig Phillips, in *The Captive Sea*, says that the surest way to ruin a net is to catch a porcupine fish in it. The more tightly the fish feels itself imprisoned the more it blows itself up, and its body remains inflated with the spines sticking out. Phillips deals with this fish by inserting a plastic tube into its throat, which deflates it. Does a shark suffer the fate of the net, as Hegner suggests, or has it some trick of deflating its prickly victim?

Somewhat useless fish

South Sea Islanders used to make war helmets of the dried skins of porcupine fishes.

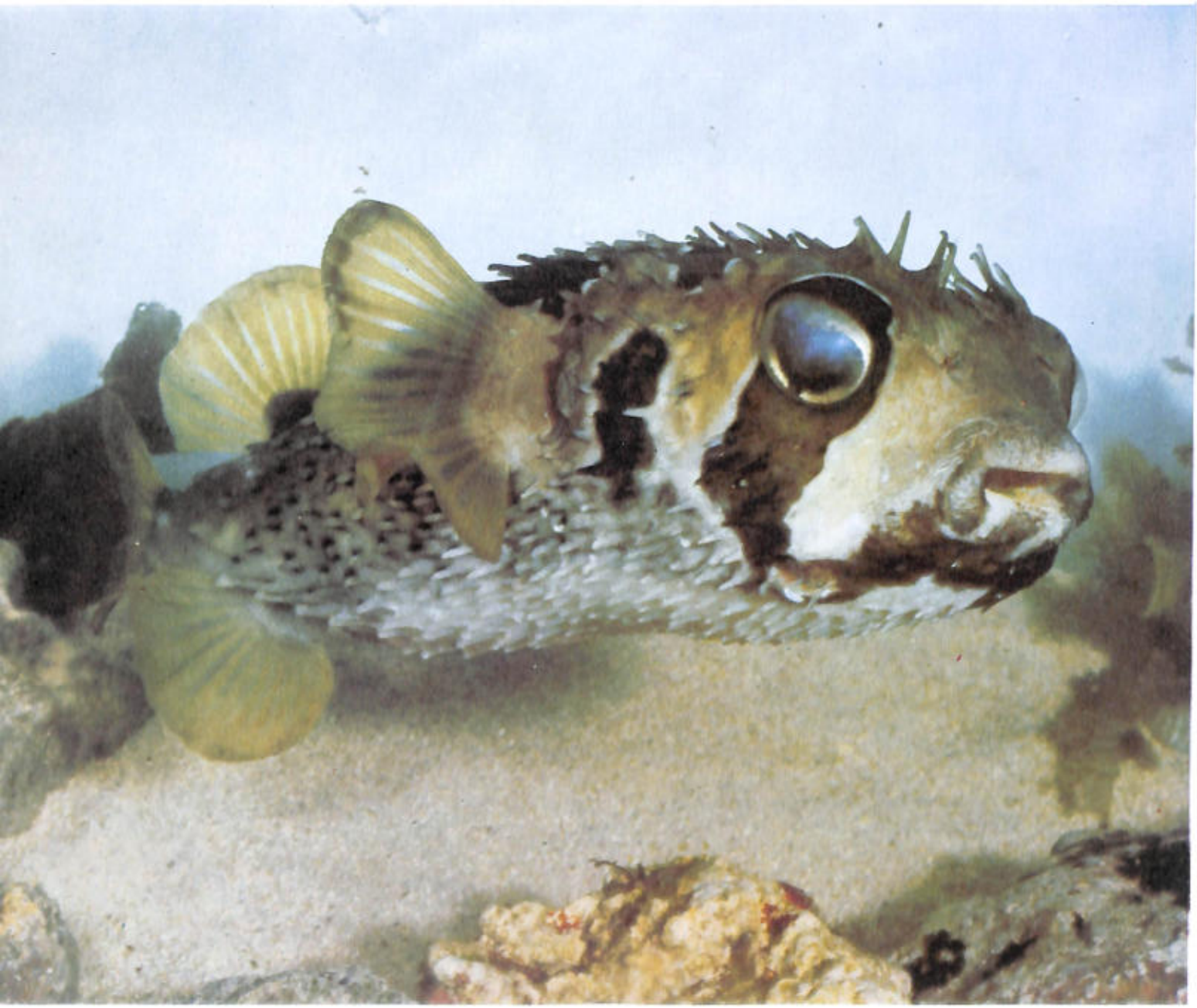


G Mundey

△ *Careful guidance for a porcupine globe fish. Its spines may be up to 2 in. long.*
▽ *Porcupine globe fish swimming slowly along the sea bed, its spines lying flat. The spines are only erected when the fish inflates itself.*

In the Far East they have been used as lanterns, the dried skin hung up with a candle inside or, in more modern times, an electric bulb in it. In southern England it used to be common to see a dried dead porcupine fish hanging in a fishmonger's shop, acting as a sort of trade sign. These are about the only uses man makes of the porcupine fish except that in some parts of the world it is eaten. It has a bad reputation, however, and care and know-how are needed in preparing the fish for the table because a poison in its liver and skin can contaminate the flesh if the cook does not prepare it correctly.

class	**Osteichthyes**
order	**Tetraodontiformes**
family	**Diodontidae**
genus & species	***Diodon holacanthus*** **D. *hystrix*** *porcupine globe fish, others*



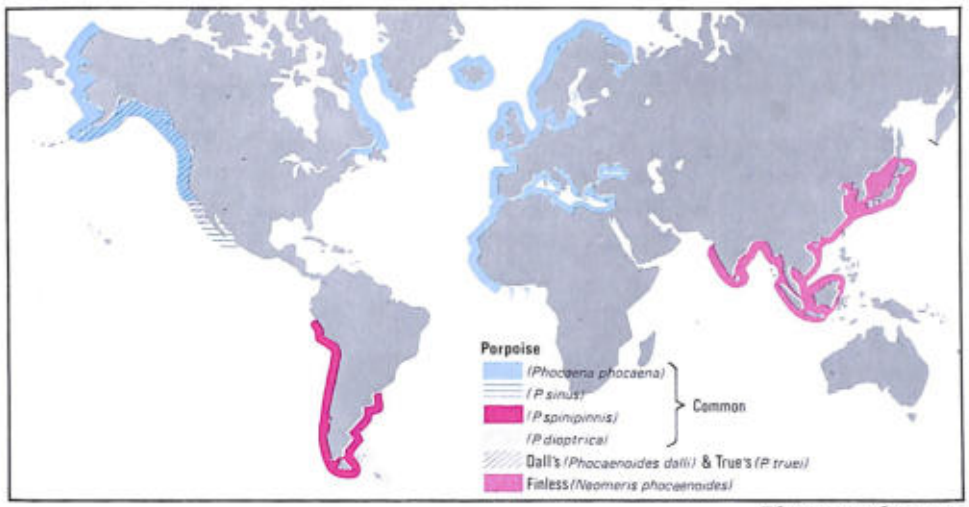
Peter Hill

Porpoise

Those of us who have seen small whales from the shore or the deck of a ship may have wondered whether they were porpoises or dolphins. Quite often the names are used arbitrarily to cover any small whale and the situation is complicated because the common porpoise of Americans is the bottle-nosed dolphin of the British, while the British common porpoise is the American harbor porpoise. Often little more is seen than a rolling back some distance out at sea, but with a good view it is quite easy to distinguish a porpoise from a dolphin. Common and bottle-nosed dolphins are larger than porpoises which reach a maximum of 6 ft, but the main distinguishing features lie in the shape of the body. Porpoises have less streamlined bodies and blunt snouts, lacking the 'beaks' of the dolphins. The flippers are broad and rounded, those of the dolphin curved and tapering. The back fin, the part most often seen, is small and fairly square in the porpoise but more conspicuous, curving backwards to a point in the dolphin.

There are four species of common porpoise. ***Phocaena phocaena*** *lives in the eastern Atlantic, from the Arctic sea to the coast of West Africa, as well as in the Mediterranean and Black Seas, and in the eastern Pacific from Alaska to California.* ***P. sinus*** *lives in the Gulf of California,* ***P. spinipinnis****, Burmeister's porpoise, on both sides of South America, from the River Plate to Peru and* ***P. dioptrica*** *the spectacled porpoise, ranges from the River Plate to South Georgia.*

Closely related to the common porpoises are Dall's and True's porpoises, ***Phocaenoides dalli*** *and* ***P. truei*** *of the North Pacific, and the finless porpoise,* ***Neomeris phocaenoides*** *of coasts and rivers from India to China.*



Phocaena phocaena

Arthur Christiansen

Not so playful

Porpoises live in coastal waters and are often found in estuaries, sometimes penetrating far up rivers. One porpoise was found as far up the Rhine as Cologne. They live in pairs or in schools of up to 100 and are migratory. Little is known about the courses and timing of the migrations but porpoises are most numerous in the North Sea in July and August. Porpoises leave the Baltic Sea between November and February and if the sea freezes early they are killed in large numbers.

A difference in behaviour between porpoises and dolphins is that porpoises are less playful. They rarely leap out of the water and do not follow boats as often as dolphins.

Slippery food

Porpoises feed mainly on fish, together with some squid and crustaceans. The fish caught are pelagic rather than bottom-living species, which accords with the porpoises' way of life. They usually swim near the surface but have been caught in nets 200 ft or more deep. Fish more than 1 ft long are rarely taken, their favourite being herring; pollack, whiting, cod and sardines are also taken. Porpoises are frequently accused of eating salmon as they enter estuaries, but there is little firm evidence for this. True's porpoises have been found with lantern fishes in their stomachs. These are deepsea fishes that come to the surface at night.

Although porpoises are armed with 16–27 teeth on the sides of each jaw, they swallow their prey whole. The teeth are spade shaped and are used for gripping slippery animals. Dall's and True's porpoises which feed largely on cuttlefish have a full set of teeth but these never show through the gums.

Suckled at the surface

Porpoises mate between July and October, gestation lasts nearly a year, the single baby rarely being born before June. The babies, which are suckled for 8 months, are half the length of the mother when born. When suckling, the mother porpoise 'blows' lying on her side. This allows the blowhole of the baby to break the surface without it having to release the nipple. Porpoises live about 15 years.

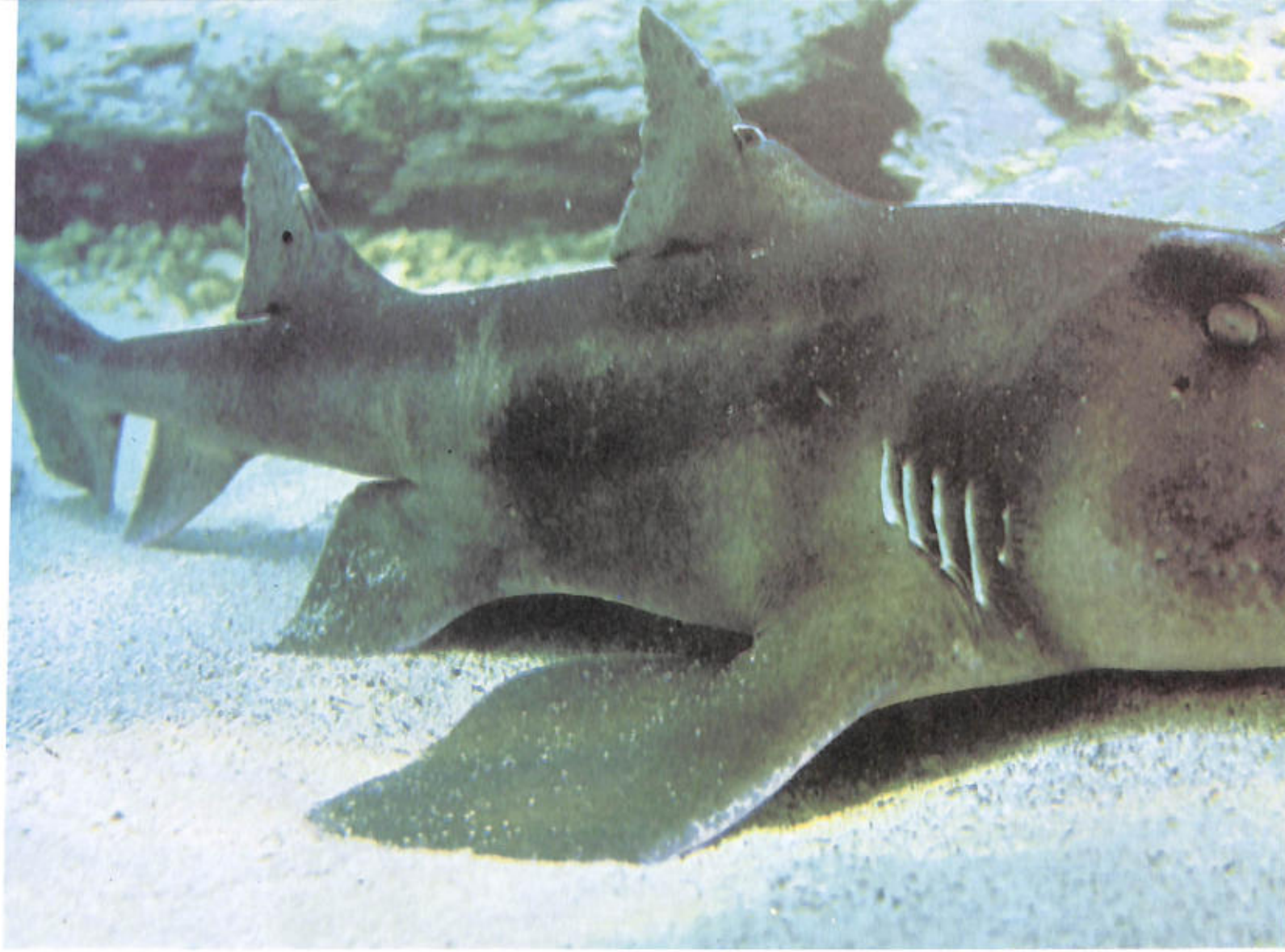
Royal delicacy

Porpoises fall prey to sharks and killer whales and at times are hunted by man. They are eaten by Indians living on the coasts of North and South America. In Normandy there was once an important porpoise fishery. The meat was eaten and the blubber rendered into oil for lighting. In mediaeval England, porpoise flesh was considered a royal dish.

Surf riders

Although they usually ignore boats, porpoises share with dolphins the habit of riding in the bow waves of fast-moving ships, being swept along almost effortlessly. KM Backhouse and PJG Smart have described this behaviour in the *Proceedings of the Zoological Society of London*. The porpoises were swept forward with their tail flukes in the breaking part of the wave. The bow wave of a ship is caused by water being thrown out of the way, over the top of the water immediately ahead. A large, fast-moving ship sweeps a considerable wall of water in front of it. The porpoise, or dolphin, uses this to propel itself in much the same way as a surf rider on his board. The trunk is raised so that the tail flukes are presented to the rush of water which lifts the porpoise as well as moving it forwards. Both surf rider and porpoise have to keep the forepart of the body clear of the slower water in front of the body which would pull it down. Humans use the surf board to provide lift at the front while porpoises use their flippers. Small boats do not provide large enough waves for riding. Porpoises have been seen trying to ride them but they either get left behind or suffer the same fate as the incautious surf rider: there is not enough lift so their heads sink and they are thrown tail over head.

class	**Mammalia**
order	**Cetacea**
family	**Phocaenidae**
genera	***Neomeris*** ***Phocaena*** ***Phocaenoides***



Port Jackson shark

The prominent nostrils either side of the snout, and a toothy mouth, permanently half open, give the Port Jackson shark a repulsive look when seen head on. It is the best known of 10 species of horn shark. They are 4½—5 ft long and are noted for the shape of their teeth and jaws.

The heavy head is blunt in front with a terminal mouth and 5 gill slits on each side. A ridge runs over the top of the head beside each eye. There are two dorsal fins, each with a stout spine in front, large pectoral fins and a single anal fin. The shark is brownish-grey.

The Port Jackson shark lives in the seas off southern and eastern Australia. Other species live in the Indian Ocean and in the Pacific, around the Malay Archipelago, Japan, the Galapagos and off California. They are a primitive race of sharks related to those whose fossils date back 150 million years, to the Jurassic period. The large spines associated with the fins were a feature of the forerunners of sharks and also of the earliest known true sharks.

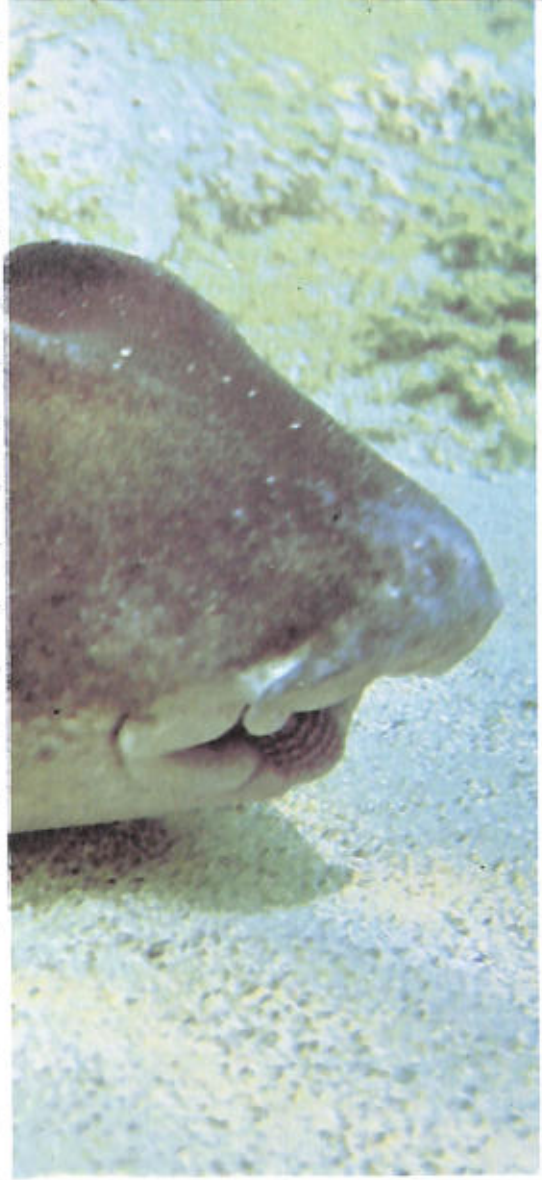
Tombstone teeth

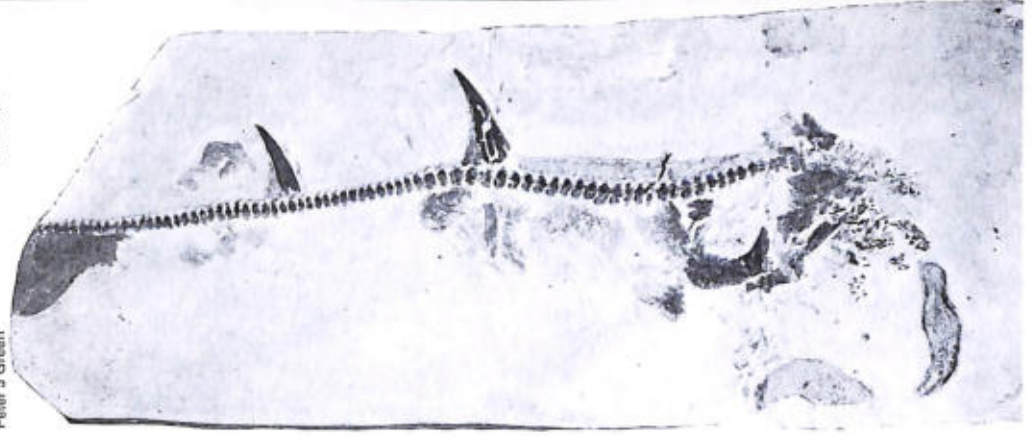
These fairly sluggish sharks live near the bottom of shallow waters where they feed mainly on clams and other molluscs, and crustaceans such as crabs, which they crush with their unusual teeth. The upper jaw fits into a deep groove and is attached to the cranium by strong ligaments; the lower jaw is slung from the cranium by the hyomandibular cartilage. The jaws themselves are lyre-shaped and the teeth have an unusual pattern. In the front half of each jaw they are very small, cone-shaped and numerous, crowded together and looking rather like the teeth of a file. About halfway along the jaw they begin to get larger and these larger teeth are abruptly replaced by two rows of very much larger flattened teeth, with 3 or 4 rows of medium-sized teeth beyond these at the rear end of the jaw. Although nothing is known of how these sharks feed it is reasonable to assume that the small teeth in front of the jaw are for seizing prey and passing it backwards into the mouth to be crushed by the large pavement-like grinding 'molars'.

Buried eggs?

There is a sort of courtship in which the male nibbles the female at various points on her body until mating occurs. As in all sharks the male has a pair of claspers associated with the pelvic fins. It used to be thought that these were used to clasp the female during mating but fairly recently it has been realized they are used for transferring sperm to the female, fertilisation being internal. The eggs are laid one at a time at fairly long intervals over a period of 2 months. Each is in a cylindrical capsule of a brown horny material. Around the cylinder, which narrows at the lower end, are two spiral flanges. Each capsule looks very like the end of a post-hole driller. As they float down through the water their shape probably causes them to spiral and it is hard to believe the capsules do not anchor themselves in the sand by this boring, twisting action. If they do, this may be a protection against the eggs being eaten by bottom-feeding fish—such as the Port Jackson shark! The eggs take 7—8 months to hatch, the baby fish being 8 in. long when it leaves the capsule.

△ *Dozing shark—the slightly grotesque Port Jackson shark has a large bulbous head and a sharp spine on each of its dorsal fins.*
▷△△ *150 million year old fossil relative.*
▷△ *Teeth of Californian horn shark. The small sharp front ones probably seize the prey, the flat back teeth acting as crushing plates.*
▷ *In hand—a female Californian horn shark and two of her strange corkscrew shaped eggs.*





Ron Taylor

Peter J Green

John Tashjian at Steinhart Aquarium

John Tashjian at Steinhart Aquarium

Poison spines

The spines on the front of each of the dorsal fins are formidable weapons. As well as being vicious spikes they are grooved and the tissue in the grooves gives out a poison which can cause painful, possibly dangerous, wounds in human beings. The main enemies of a 5ft shark are likely to be other larger sharks, and fishermen, as their flesh has a delicate and excellent flavour when cooked. Against other sharks a sluggish swimmer like the Port Jackson shark is unable to use speed to escape. It therefore needs some form of passive defence. It is known that pike learn to leave the 3-spined stickleback alone. Perhaps in the same way other sharks learn to keep out of harm's way by giving the Port Jackson shark a wide berth.

class	**Chondrichthyes**
order	**Heterodontiformes**
family	**Heterodontidae**
genus & species	***Heterodontus francisci*** *Californian horn shark* ***H. phillippi*** *Port Jackson shark*

Popperfoto

Portuguese man-o'-war

This colourful jellyfish with a sting almost as powerful as a cobra's venom floats on the surface of the sea in mid-ocean. Occasionally thousands are cast up on the coasts by strong winds. Each Portuguese man-o'-war is in fact a colony composed of four different kinds of polyp. The most obvious part of the Portuguese man-o'-war is a bladder-like, gas-filled float. This polyp may be up to 12 in. long, 6 in. high and 6 in. across. It carries a high crest and its colours range from blue through purple, lavender and pink to scarlet. On the underside of the float and hanging down in the water, are many polyps. Some are concerned only with feeding, others with reproduction, while the long trailing tentacles armed with stinging cells that may be 40 ft long, are used for catching the prey.

***Physalia,** as it is scientifically called, is found in warm seas throughout the world but especially in the North Atlantic where it is normally restricted to the area covered by the circulatory currents of the Gulf Stream. It is common in tropical and subtropical areas of the Indian and Pacific Oceans, and off the coast of New South Wales, Australia, is a particular nuisance to bathers and is known as the bluebottle.*

Helpless but dangerous sailor

The wind catches the sail-like crest on the float of the Portuguese man-o'-war, and drifts it across the sea. The float can be deflated in storms and then the jellyfish submerges. The bladder is filled with a mixture of gases secreted by a gas gland. The gas is similar to air but contains more nitrogen as well as carbon monoxide, argon and xenon. The pressure of the gas is regulated by muscles in the thin membrane forming the wall of the float. Under normal conditions these cause the float to twist and contort from time to time, so the bag is dipped into the water, keeping its outer surface moist. After being deflated the float can be reinflated in a few minutes. On a rough sea tentacles are spread all around the float to keep it on an even keel.

The Portuguese man-o'-war may be caught in persistent winds, blowing from one quarter over a period of weeks, and carried hundreds of miles from their normal range to be cast up in large numbers on the coasts of Europe or the United States. When this happens the bladders lie scattered in the drift line on the shore, the tentacles and polyps soon becoming shrivelled and dried. Even when dried the stinging cells are dangerous and when handled carelessly, can produce a red weal on the skin like a severe burn.

◁ *Driven along by the wind catching its float,* ***Physalia physalis*** *sails close to the rocks.*
▷ *A mass of deceptively beautiful trailing tentacles floats above a mushroom coral.*

Increase a thousand-fold

In a well-grown Portuguese man-o'-war there may be a thousand polyps and they all come from one larva. This grows into a tiny bladder with a gas gland at one end. At the other end a tubular mouth grows out. This is the first feeding polyp. Between the bladder and the first feeding polyp there appears, at a later stage, what is called the budding zone. The first stinging tentacle grows out from this, to be followed by more feeding polyps and stinging tentacles. By further budding the reproductive polyps are formed, some male, others female. The bladder meanwhile has grown into a float with a crest. It continues to grow in size and the three kinds of polyps increase in number by budding until the mature jellyfish is formed. It probably lasts only a few months but before dying it sheds its eggs and sperm into the sea. The eggs are fertilised and from them the tiny larval bladders develop.

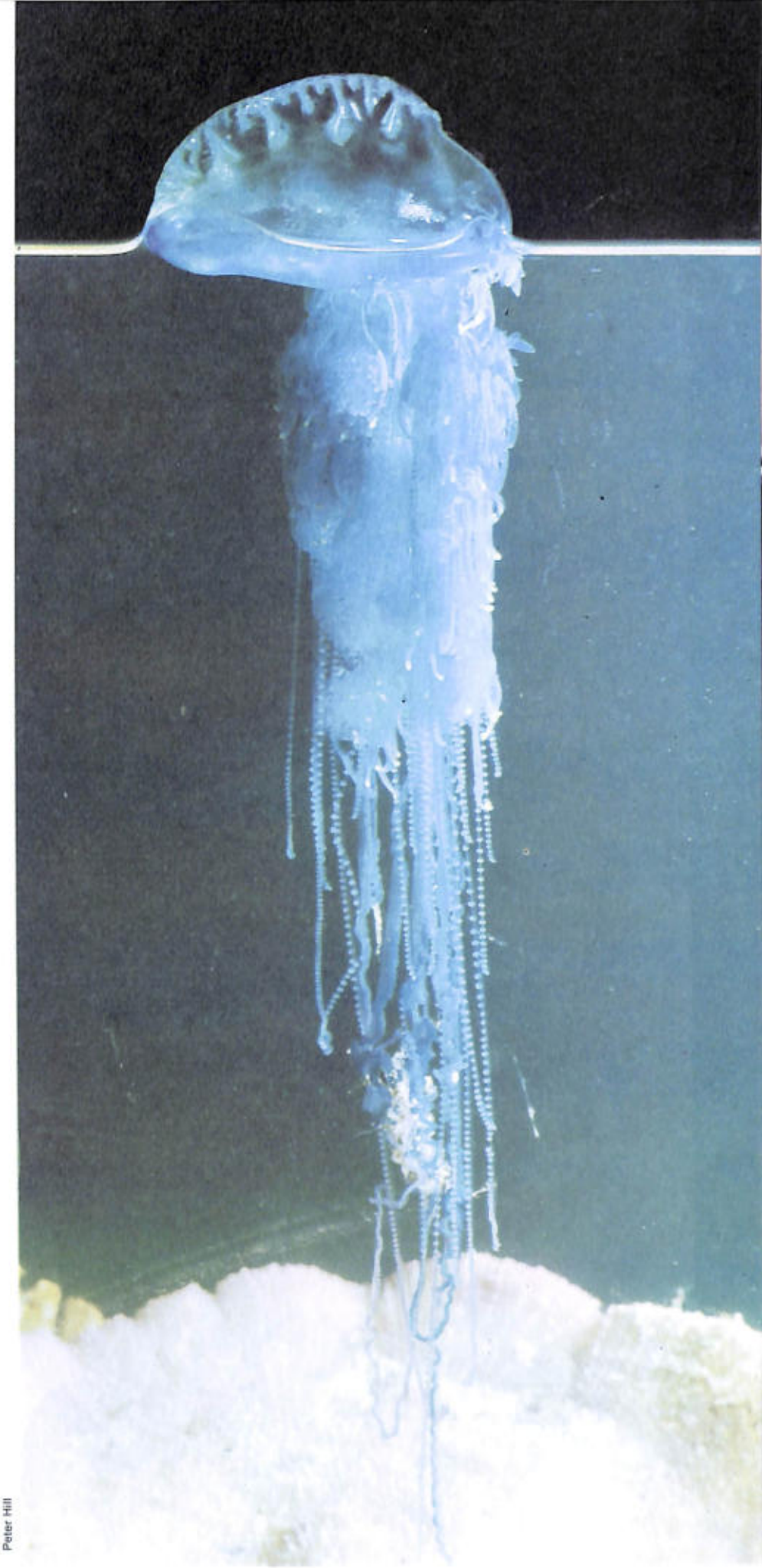
Turtles wolf jellyfish

In spite of their vicious stings the Portuguese man-o'-war is eaten by several animals, especially by the loggerhead turtle (p. 1469). This has been seen to eat its way through a shoal of the jellyfish, its eyes swollen and almost closed from the stings. It seems to be almost immune to the poison and insensitive to the stings. There is also a small fish *Nomeus albula* which seems to enjoy an immunity to the poison and although it does not prey on the jellyfish it robs it of some of its food. This is the small fish long renowned because it shelters among the tentacles of the jellyfish. Only within recent years has it been studied and shown to rob its host. Moreover, although it does not have complete immunity to its host's poison it can survive 10 times the dose that would kill another fish of the same size.

Why man-o'-war?

The first written account of this jellyfish, in English, seems to be in Hans Sloane's *Travels to Jamaica*, published in 1707. In this it is implied that the jellyfish resembles the Portuguese caravel, a ship of 100–150 tons, with a broad bow and high narrow poop. Sloane's diary contains the following entry: 'On Tuesday 11, -when we were in about forty-six degrees of northern latitude I first saw what the seamen call a Caravel or Portuguese Man of War, which seems to be a Zoophytum, or of a middle nature between a Plant and an Animal . . . of a blue, purple, yellowish and white colour, that burn more violently than those of the North-Sea, they do suck themselves so close to the skin that they raise Blisters, and cause sometimes St. Anthony's Fire.'

phylum	**Cnidaria**
class	**Hydrozoa**
order	**Siphonophora**
family	**Physalidae**
genus & species	***Physalia physalis*** *Atlantic* ***P. utriculus*** *Pacific and Indian*



Peter Hill

Man-o'-war in action

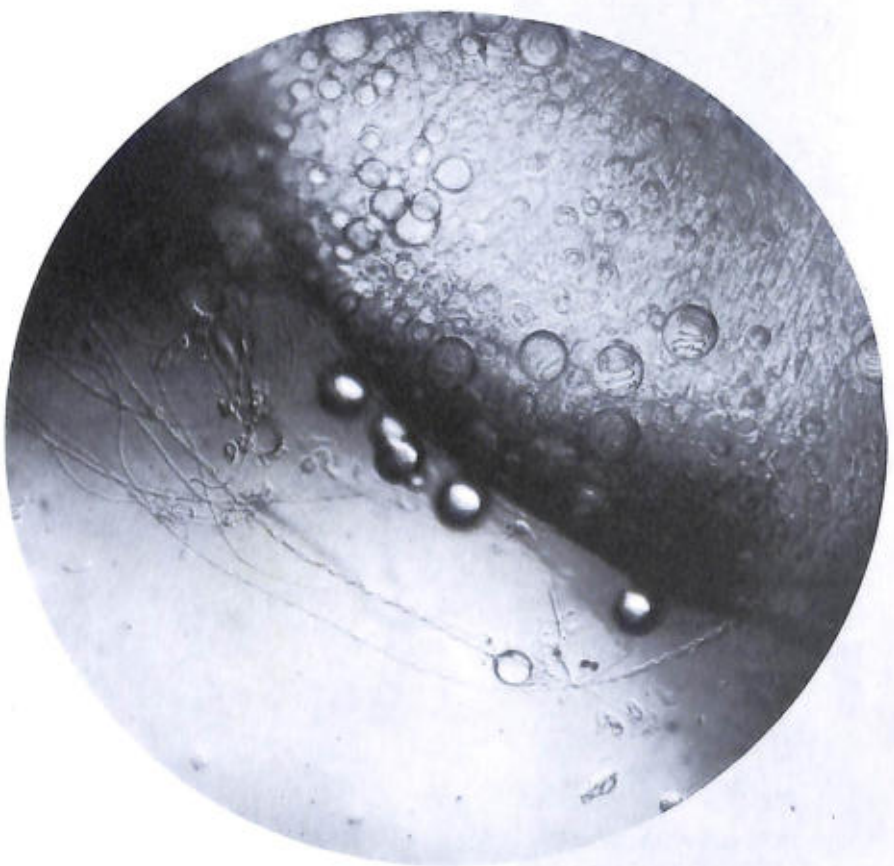
The poison contained in the stinging cells is 75% as strong as a cobra's venom. Each stinging cell, when stimulated by touch or chemicals in the water, shoots out a long tube, as in the hydra (p. 1283), but the surface of the tube in *Physalia* is studded with hooks, barbs and spikes of different shapes and sizes. The tube will even penetrate rubber gloves, and it will go deep into the skin of small animals, remaining firmly fixed while the poison flows down the tube from the capsule of the stinging cell.

The stinging tentacles, with batteries of nematocysts, are used for capturing planktonic crustaceans and small fishes. We know the stinging cells are shot out when something touches them. They are also shot out when the chemical glutathione comes into contact with them. This amino acid is given out from the skin of injured or dead animals, so the jellyfish could be as much a scavenger as a predator.

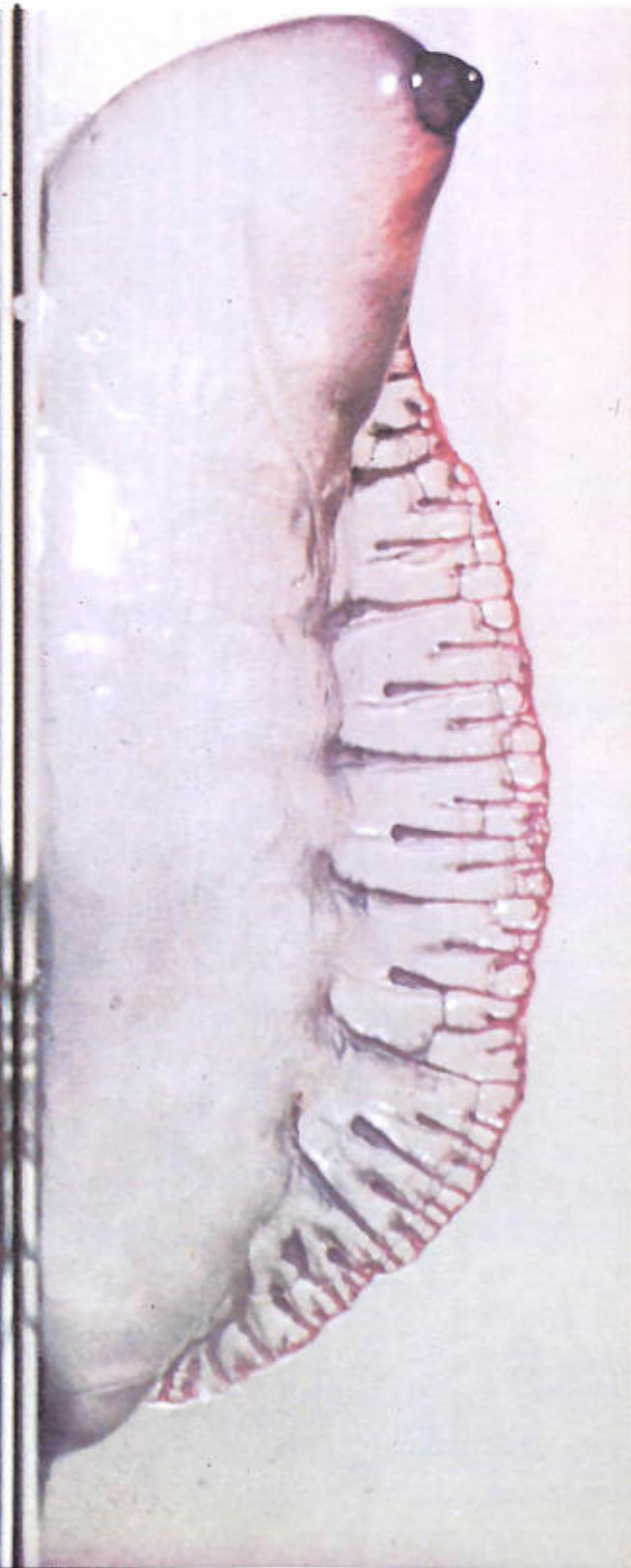
As a fish is drawn up by the stinging tentacles, the feeding polyps, which are flask-shaped, become agitated and move their mouths around searching for the food. Once they get the taste of it their mouths open wide and they fasten sucker-like onto the body of the fish. The wide mouths of a dozen feeding polyps spread over a fish and almost enclose it. The polyps pour digestive juices onto the fish. Smaller prey are eaten whole by a feeding polyp.

▷ *Victim held: goldsinny* ***Ctenolabrus rupestris.*** *On left the crest has momentarily heeled over.*

▽ *Portion of a tentacle ×250 showing discharged tubes and undischarged capsules with tubes coiled inside.*



DP Wilson



DP Wilson

Potoo

Potoos or wood nightjars are a family of 5 species related to the nightjars. They have large mouths, but lack the nightjars' surrounding bristles. The plumage is dark brown, streaked and mottled with buff, white and black, which makes a potoo inconspicuous. It has short legs and long wings and tail. The eyes are very large with yellow or brown irises.

Potoos live in Central and South America and in the West Indies. The largest is the great potoo, 19½ in. long, with unusual scalloped upper eyelids. The bill has a 3in. wide gape. The great potoo is found from Panama to Peru and southern Brazil. The common or grey potoo is the most widespread, ranging from southern Mexico to Argentina, and is also found in some of the West Indies, such as Jamaica, Hispaniola and Trinidad. It is 17—18 in. long, of which half is tail.

perched in an owl-like posture, with its head facing forward. The captive potoo was very sluggish. This was probably because it was hand-fed and reared and never left its perch of its own free will.

Hawking for insects

Potoos hunt from their perches, keeping still, until an insect flies by, then they swoop out to catch it in the enormous gape and return to the perch. They can catch large insects such as beetles, bugs, locusts and termites. When hawking continuously for insects potoos catch them in the same way as owlet nightjars (p. 1792) rather than like nightjars (p. 1718).

Hidden in the open

Potoos lay their white eggs in exposed positions yet very little is known about their nesting habits because the nests are so hard to find. Even when told that a potoo's nest is nearby it is unlikely that a person will be able to locate it. The single egg is laid in a crevice or depression in a tree stump or the scar where a branch has fallen off. The potoo perches over the egg, covering it with its breast feathers and holding its long tail close to the trunk of the tree. In this position it is easily mistaken for a bracket fungus or the projecting stub of a broken branch. When relaxed the potoo perches with plumage fluffed and head pulled in to its shoulders, but when disturbed the head is extended with the bill pointing skywards and slightly open, the eyes being nearly closed. This makes the potoo even less birdlike and in this posture it can be handled, when it will open its eyes wide, snap its beak and gape aggressively. Potoos also perform distraction displays, flapping and cavorting on the ground.

The incubation period is not known but both parents probably take part. The newly-hatched chick is brooded, after which it perches inconspicuously like the parents, remaining on the stump for about 6 weeks.

Constance P Warner

P Morris

▽◁ *Say ah! A potoo's gape is extraordinarily large—an effective trap for its insect prey.*
▽▷ *When relaxed the common potoo looks like a little fluffy toy with glass eyes.*

Weird calls

One of the features of the potoos and their relatives is their strange calls, often booming, or shrieking, which have given rise to many of their common names, for instance, nightjar, poor-will, whip-poor-will and *guachero* (the Latin American name for oilbird meaning the one who wails). The potoo is also named after one of the cries of the common potoo. This two-syllable call is like a yowling cat and in Haiti potoos are called 'howling cats'. Another of its cries is described as 'poor-me-one', a far-carrying, mournful whistling which when heard close-to can be shown to be composed of 7—8 descending notes. As these calls are heard at night it is not surprising that potoos and their relatives are connected with superstitions. In Trinidad the oilbirds are supposed to carry the souls of criminals and to the Indians of South America the wails of potoos are evil omens.

Bright eyes at night

A potoo may often be first encountered as a pair of large, yellow or brown eyes in the dark. Potoos are nocturnal, like their relatives, so very little is known about their habits. They roost motionless by day, their mottled brown plumage making them very difficult to find. Great and common potoos live in open woodland and plantations, having favourite perches on tree stumps and branches. They are most often seen by motorists when their large eyes show up as two brilliant yellow spots in the headlights. Otherwise potoos are usually known only by their mournful calls. Drawings of potoos generally show them as roosting with their bills pointing upwards, but a captive potoo

class	**Aves**
order	**Caprimulgiformes**
family	**Nyctibiidae**
genus & species	***Nyctibius grandis*** *great potoo* ***N. griseus*** *common potoo* *others*

Potto

The potto is one of the slow-moving lemur-like lower primates, related to the loris (p. 1475) and angwantibo (p. 135). It is 14–16 in. long, with a tail of 2–3 in. (longer than in its relatives) and weighs about 2–3 lb. It has thick, usually dark brown woolly fur, rounded ears nearly hidden in the fur, and big round staring eyes. Like its relatives, it moves slowly. Its thumbs and big toes are long, its index finger and second toe being greatly reduced so that both hands and feet form strong clamps. The index finger is not quite as reduced as in the angwantibo. Its snout is fairly short, the shape of the potto resembling that of a little bear. The most peculiar feature of the potto is its possession of four or five 'spines' on its back. These are the spines of the neck vertebrae which are unusually long so they protrude slightly through the skin. It is now known that these spines are for defence, although they are very blunt and are in a very peculiar position to be defensive. Recent examination has shown that they are covered with a thin layer of highly sensitive skin.

The potto lives in the African forest belt from Guinea in the west to the Rift valley in East Africa. In Zaire it is found only in the area to the north of the Zaire river.

Not so gentle

Living in deep forest pottos lead solitary lives, moving slowly about at night along the lower branches of trees, spending the day curled up almost into a ball, with the head tucked between the arms and the hands and feet clamped tightly to a branch. At dusk they come out from their hiding place, which is usually a tree-fork or a tangle of twigs and leaves. When two meet on their nocturnal wanderings, they may groom each other, and stay together for a while. The males are probably territorial since they mark branches with the secretion of glands situated near the anus and are often aggressive towards each other, threatening with open mouths and making little downward lunges with their heads. Pottos are fairly aggressive and hard to tame.

As it moves along a branch, the potto lets go with one hand or foot at a time. The hand is moved forward and the fingers close around the branch in a vice-like grip. Then a foot is moved to grip in the same way. This is not a very rapid method of locomotion but the potto is not quite as slow-moving as its discoverer, Bosman, declared in his description of it written in 1704; he spoke of 'its lazy, sluggish Nature; a whole day being enough for it to advance ten Steps forward. Some Writers affirm—that when this Creature has climbed upon a Tree, he doth not leave it until he hath eaten up not only the Fruit, but the leaves intirely; and then decends fat and in very good case in order to get up into another Tree: but before his slow pace can compass this, he becomes as poor and lean as 'tis possible to imagine: And if the trees be high, or the way anything distant, and he meets with nothing on his journey, he inevitably dies of Hunger, betwixt one tree and the other'—a slightly hazardous way of feeding.

This is highly fanciful, as might be expected from an author who goes on to say ''tis impossible to look on him without Horror . . . he hath nothing very particular but his odious Ugliness . . . I don't believe anything besides so very disagreeable is to be found on the whole Earth'. It is very like poetic justice that (to distinguish it from the angwantibo, or golden potto) it is often called after its detractor—Bosman's potto!

▽ *Caught in the middle. A potto, firmly gripping the branches, peers out from between them with its large, round eyes. Its thumbs and big toes are long, its index fingers and second toes very short, so both hands and feet form strong clamps around the branches.*

▷ ***Overleaf:*** *Potto in its natural habitat in Uganda. The potto never lets go: it moves only one foot or hand at a time.*

Okapia

Must hold on to something

Contrary to Bosman, pottos can move quickly when they put their minds to it, which is, however, not very often. They creep up on nesting birds, very slowly so as not to be noticed, and grab the victim with a sudden swift lunge. This has been recorded of pottos in Uganda. In the Ivory Coast, however, the potto is thought to be purely vegetarian. In general pottos eat leaves and fruit, insects, snails, lizards, eggs and young birds. Again, contrary to Bosman, they dislike crossing open spaces, feeling uncomfortable unless their hands and feet are clasped round a branch. They move from tree to tree only when they can do so without descending to the ground first.

Nursemaid puppies

The female comes into season about every 40 days, births, of one baby at a time, occurring at all seasons. The infant clings tightly to its mother's belly, snuggling against her for warmth. A young potto reared at the London Zoo during the last century suffered from the cold, so it was given a hare-skin bag into which it used to go for warmth. A dog in the Zoo had recently given birth, and when the puppies were old enough to walk around they were made to play nursemaid to the baby potto. It would cling to a puppy's belly until the poor 'host' became too uncomfortable, then the potto was transferred to another puppy—but this was a more difficult procedure than it might appear, as the young potto clung so tightly to its foster 'parents'.

Pottos grow rapidly; their spines begin to appear at 30 days. When the mother is moving around in the trees, she often 'parks' her baby, leaving it clinging underneath a branch where it will be quite safe until she comes to fetch it. A potto lived 9 years in Bronx Zoo, New York.

Spines towards the enemy

We are not sure what feeds on pottos. One suggestion was that the palm civet *Nandinia* might do so, because of its size and the way it hunts in trees, but palm civet stomachs so far examined have all contained nothing but fruit! Perhaps some of the smaller cats, like the African golden cat *Felis aurata* feed on pottos; undoubtedly pythons do occasionally. At all events the potto has a well-defined defence response: it curls up, clinging with its hands and feet, its head tucked between its arms as in sleep, turning its 'spines' towards the enemy. If touched or threatened further, the potto will suddenly let go of the branch with its hands and lunge outwards with them at the enemy. At the same time it can inflict painful bites with its small sharp teeth.

What's in a name?

The slow-moving pottos and lorises are, strangely enough, most closely related to the bushbabies, which move as rapidly as the potto does slowly, leaping with their long hindlegs. Yet although so different in their way of life they are very alike in structure. It is hard, for example, to tell their skulls apart. Fossils from the late Miocene deposits of East Africa, 14 million years ago, show that the pottos and lorises, on the one hand, and the bushbaby (or galago) group, on the other hand, had already become separate groups. One of these fossil types given the name *Komba*, is ancestral to the galagos, while confusingly, another named *Progalago*, is ancestral to the potto. Even more disconcerting is the fact that one fossil named *Propotto* later turned out to be a fossil fruit bat!

class	**Mammalia**
order	**Primates**
family	**Lorisidae**
genus & species	***Perodicticus potto***

Prairie chicken

The two species of prairie chicken are grouse that live in eastern and central United States. The greater prairie chicken is 17 in. long, pale brown with black barring. The face is white with a black eyestripe. The male has an orange crown, large orange airsacs and an epaulette of stiff pointed feathers on the neck which is raised during display. The lesser prairie chicken is similar, but an inch smaller and has violet airsacs. The feet are slightly feathered to form snowshoes.

Before the spread of European civilisation prairie chicken were widespread over the grasslands of the United States, from the Canadian border to Texas and eastwards to the Atlantic. The main centre of their population was the previously vast prairies of the United States, but they also flourished in open woodlands where there were grassy clearings. The lesser prairie chicken lives in country dominated by dwarf oak bush. They are now very much restricted. Predators have had some effect, particularly domestic cats, but radical alterations of the habitat by man is the main cause.

Habitat destroyed

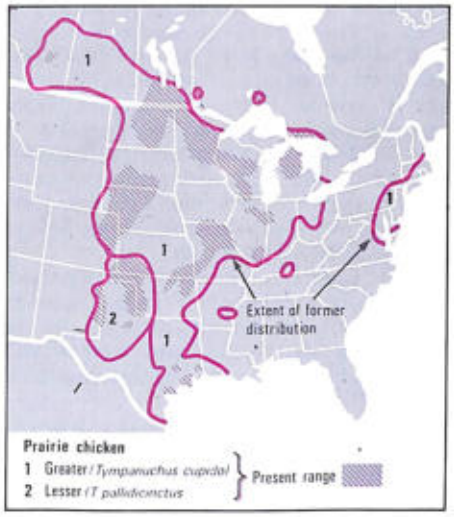
When Europeans first spread westwards in North America, cutting the woodlands down for pasture, the prairie chicken flourished, as its food is grass grains. Later the prairies were ploughed up, robbing the prairie chickens of their homes. This process was accelerated during and after the First World War when grain-growing was a strategic necessity and the development of mechanisation allowed large areas to be cultivated. The prairie chicken became extinct in the eastern part of its range and only survived in isolated pockets. Even more advanced farm machinery threatens some of these pockets but others have been set aside as reserves.

One race of prairie chicken has already become extinct. This is the heath hen, a subspecies of the greater prairie chicken, that used to live along the North Atlantic sea-board in what were probably grasslands that sprung up after forest fires. The heath hen disappeared from the mainland of New England about 1835, but survived on the island of Martha's Vineyard until 1932.

Booming grounds

Like other grouse (p. 1112), male prairie chickens meet in communal display grounds called 'booming grounds', which are used from one year to another. The males gather in early spring and every day for several months, at dawn and dusk, they indulge in their displays. The orange airsacs are inflated and the neck epaulette and tail are raised. Once arrayed, the males scurry to and fro and spin in circles with head held low, wings drooping and tail alternately fanned and shut with a loud click. While dancing the prairie chickens utter a three-syllable boom which in chorus can be heard as a continuous humming for up to 4 miles which is the approximate distance between the different booming grounds.

Each male prairie chicken stakes out a territory within the booming ground. Presumably the boundaries of each territory are determined by the effects of the displays on the neighbours. Observations on marked prairie chickens show that territories within a booming ground vary considerably in size and overlap to some extent. Females visit the booming grounds to mate and then depart to rear the family by themselves. The most successful males are those with the largest territories. On a booming ground that was watched for 2 years there were nine males. Each year one of the nine held sway over large territories and took part in about 70% of the matings within the booming ground. Presumably the male with the largest territory was in some way dominant over other males and able to hold a large territory by his displays. In this way most of the prairie chicken offspring are



◁ *Below the belt? A prairie chicken lunges at his opponent with his beak during a territorial dispute. Each male holds sway over a section of the booming ground, the size of this territory depending on his strength and the effect of his displays on his neighbours.*
▽ *The critical approach. A proud cock eyes the back of a hen before mounting her to mate. The hens visit the booming grounds to mate. Most of them choose the dominant males—those with the largest territories.*

fathered by the dominant male, a clear example of selection of the fittest.

The female prairie chicken makes a nest of dead grasses in open grassland or under a bush. The usual clutch is 12–16, incubated for 3 weeks. The chicks leave the nest shortly after hatching and follow their mother.

Safe in the open

In the course of another study on prairie chickens, booming grounds were watched for 4 745 mornings over 24 years. Among other observations a watch was kept for predators and the reaction of the prairie chickens to them. The results were surprising for in all that time only four prairie chickens were killed on the booming grounds. Three were killed by birds, a harrier, a snowy owl and a horned owl, and one by a mongrel dog from a nearby farm. Although foxes and coyotes visited the booming grounds none made a kill. It was also noticed that the prairie chickens were more wary of dogs than of foxes or coyotes. The reaction to a ground predator was surprisingly casual. As it approached the prairie chicken walked out of the way with neck stretched up. If pressed it took flight but settled within 100–200 ft. Sometimes foxes were seen to cross the booming ground, taking no notice of the prairie chickens, who disregarded the foxes.

The conclusion to be drawn from these observations is that predation on the booming ground is far less successful than one might expect. Furthermore, if predation had been higher it would still have had no effect on the population because as we have seen, one male prairie chicken dominates the mating. If this one is killed, another will take its place. Several instances have been mentioned in this encyclopedia of conspicuously coloured male birds having nothing to do with rearing their families (and occasionally of conspicuously coloured females behaving similarly). It is usually assumed that these birds can be coloured because they will not attract predators to the nest, but here is proof that conspicuousness does not in itself attract enemies. It must also be noted that as the booming grounds are open spaces, the enemies themselves would also be very conspicuous.

class	**Aves**
order	**Galliformes**
family	**Tetraonidae**
genus & species	***Tympanuchus cupido*** *greater prairie chicken* ***T. pallidicinctus*** *lesser prairie chicken*

Prairie dog

Prairie dogs are hamster-like, short-tailed ground squirrels that are so named because of their barking calls. The length of the head and body is about 12 in. and the tail about 3½ in. Apart from being slightly flattened, the tail bears little resemblance to the tail of tree squirrels. The head is more squirrel-like except that the ears are very small. The fur is yellowish-grey or brown with lighter underparts and the tip of the tail is black. The five species are all very similar in appearance.

They inhabit the plains and plateaus of North America, from the Dakotas to Texas, and from Utah and Arizona in the west to Kansas and Oklahoma in the east, and also northern Mexico.

Prairie citizens

Prairie dogs live in vast 'towns', although these are smaller than they used to be because such large concentrations of animals inevitably came into conflict with man. In 1901, one town was estimated to cover an area 100 by 240 miles and to contain 400 million prairie dogs. As with other colonial or social animals prairie dogs have a social organisation, which, as must be expected with such vast colonies, is very complex. A single town is divided into a number of wards, whose boundaries depend largely on the geography of the area. The wards are divided into a number of coteries, each covering less than one acre. The coterie is the base unit on which the prairie dog's life is founded. It is the family unit that defends its territory and individuals rarely venture from it. If they do, they are likely to be chased back by members of neighbouring coteries. A typical coterie consists of an adult male, three adult females and a variable number of young prairie dogs. The members of a coterie recognise each other and are on friendly terms, and except for the very young ones, they jealously guard the coterie's boundaries. Apart from squabbles along the borders, members of the coterie, including the youngsters, advertise their territories with a display. Rearing up on their hindlegs with nose pointing to the sky the prairie dogs deliver a series of two-syllable calls.

Each coterie has a network of burrows with a large number of entrances. From the entrance the burrow descends steeply for 3–4 yd before meeting radial tunnels with nests at the end. From a distance a prairie

▽ *Passion on the prairies? The greeting kiss inhibits aggression between members of one family, at the same time enabling a trespassing stranger to be detected.*

▷ *Reflecting on more youthful days? An adult prairie dog sits in the sun and relaxes.*

Bagby Duff

dog town appears pockmarked with craters because each burrow entrance is surrounded by a volcano-like cone. This is more than the casual accumulation of excavated soil; it is a carefully built rampart of soil 1–2 ft high and up to 6 ft across. The soil is gathered from the surface, brought to the entrance and patted into place where it serves as a lookout post and a protection against floods after heavy rain.

Changing the scenery

Prairie dogs are vegetarian, feeding on grasses and other plants that grow on the prairies. Not surprisingly, the crowds of prairie dogs have a profound effect on the vegetation inside the town limits. The taller plants are eliminated. They are cut down and left to wither if they are not eaten, and the continual cropping of the grasses and herbs encourages fast growing plants with abundant seeds so the optimum vegetation, from the prairie dog point of view, is produced. There is a second advantage to this unintentional agriculture. The removal of tall plants deprives predators of cover and allows the prairie dogs a clear view from their mounds.

Perhaps the main advantage of the coterie system is that each group of prairie dogs has sufficient area for feeding, and over-grazing is prevented by not allowing other prairie dogs onto the pasture. When the population gets too big, some members emigrate to form 'overspill' towns.

Keeping the balance

The rate of reproduction in prairie dogs is slow compared with many other rodents. Each female produces only one litter a year, usually of around four pups, in March, April or May. The pups' eyes open at 33 days and they are weaned in 7 weeks.

Although comparatively few pups are born each year, the population can still increase rapidly, such as from 4 to 15 prairie dogs an acre in 3 months. This would threaten the food supply if it were not for emigrations to 'overspill' towns or suburbs. When the population rises the behaviour of the prairie dogs changes. Usually any member of a coterie can enter any burrow and any female will suckle any pup, but now the females defend their nests while the others dig burrows and feed at the edge of the town, commuting home at night. As the young prairie dogs appear the travelling adults move permanently into their new homes. The population is thus redistributed without disturbing the boundaries.

Early-warning system

Prairie dogs fall prey to many predators, particularly coyotes and birds of prey, but it is usually only the slow and sick or incautious individuals that stray too far from a burrow that are caught. As with marmots (p. 1561) prairie dogs have an alarm call that sends them all bolting for cover. This is the bark that is responsible for their name. It is a short nasal yip with several shades of meaning. When high-pitched it is the signal for immediate flight. The territorial call, however, is used as an all-clear signal.

The depredations of so many predators does not affect prairie dog numbers but the prairie dog's use of the grassy plains has led to it being nearly wiped out by man. Man wanted the grasses for his livestock, who were also in danger of breaking their legs in prairie dog burrows. Poisoning was so successful that the towns were wiped out and prairie dogs now survive mainly in national parks.

Kisses seal friendship

The efficient use of pasturage, and the harmonious life within the coteries are essential for the existence of prairie dog towns, and the whole of the elaborate social system is dependent on communication between prairie dogs. Members of neighbouring coteries keep apart by an aggressive ritual but members of a single coterie are drawn together. The basis of the ritual is the exchange of kisses. When two prairie dogs meet near a boundary they drop to their bellies and crawl slowly towards each other. On meeting they bare their teeth and kiss. If strangers, one retreats or a squabble breaks out. If friends, one nibbles the other who rolls over and allows itself to be groomed, so cementing the friendship. Within a coterie all members groom each other and at times the grooming is prolonged and the pair end up side by side. They then go off to feed, with their bodies still pressed together. At other times, two prairie dogs may merely exchange quick 'pecks' but this will confirm identification and keep the coterie harmonious.

L. Lee Rue III: Photo Res

class	**Mammalia**
order	**Rodentia**
family	**Sciuridae**
genus & species	***Cynomys ludovicianus*** *others*

▷ *The whole gang—a coterie of prairie dogs.*

Nolly Zaloumis

Pratincole

The name pratincole is derived from Latin words for 'meadow-dweller', but the alternative name of swallow plover is more appropriate for these relatives of coursers (p. 676). They are starling-sized, about 8 in. long and in flight look like large swallows, with long pointed wings and forked tails. Although their legs are short they run well, holding their bodies parallel to the ground. The middle and outer toes are connected by a web of skin and the claw of the middle toe is very long, with a comb, as in herons. The Australian pratincole lacks this comb. The bill is short, broad at the base, and pointed at the tip. The plumage is generally dull brown with white underparts and a white rump. The commonest species, called simply the pratincole, has a creamy throat edged with black. The base of the bill is shiny red and the rest black. The black-winged pratincole differs only in having black underwings. The white-collared pratincole is sooty-brown except for a white collar and rump.

The six species of pratincoles live in Africa, Asia, Australia and southern Europe. The pratincole and black-winged pratincole occasionally wander into western and central Europe, including the British Isles.

Mass landings

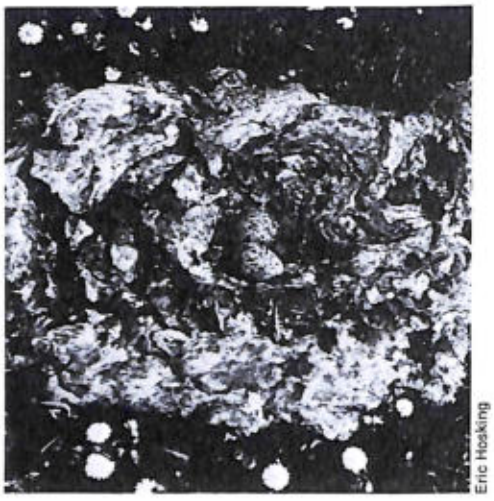
Pratincoles live in open and often very desolate country, on the edges of marshes, estuaries, plains and deserts. They have a very buoyant flight and, with their long wings and forked tails, look very much like terns. Pratincoles live in flocks, usually near water, feed together, flying to and fro after insects in a dense cloud. In the evening, especially, members of the flock call to each other with a pleasant trill-like song. When a flock settles they land packed together, all facing in the same direction. As they alight each bird stands for a few moments with its wings held stretched above its back. When they have folded their wings the pratincoles again remain motionless and even a large flock is difficult to see.

Some pratincoles are migratory, the pratincole *Glareola pratincola* moving from Asia to Australia from December to March; others merely make local movements in search of suitable living conditions.

Flying insect net

Pratincoles live on insects, particularly grasshoppers, crickets, locusts and many kinds of beetles. Flies, dragonflies, bugs and others are also taken. In Africa pratincoles are known as locust-birds, from their habit of following swarms of locusts. One black-winged pratincole was found to have 135 locusts in its crop.

◁ *Take off time—a flock of pratincoles on the river Zambesi. The flocks begin to feed around twilight, zig-zagging to and fro and emitting high pitched screams.*



Eric Hosking

Peter Johnson

Some insects are caught on the ground but pratincoles typically hawk for insects in the air. Their short, triangular bills open to expose a wide gape in which the insects are quickly 'netted'.

Dancing pratincoles

Pratincoles breed on small islands in lakes, on sandbanks in rivers, on mudflats or in deserts where their nests are fairly safe from enemies. These sites are not usually permanent and clutches may be destroyed by floods. Breeding grounds also vary from year to year. Several hundred pairs may nest together in loose colonies, each pair staking out a territory, around the nest. Intruding neighbours are threatened by lowering the breast to the ground with wings spread or half held out and tail raised. Sometimes communal displays take place on neutral ground. Several pairs gather and take part in a 'square dance', each couple bowing to the other with tails raised, bobbing their heads, even leaning against each other.

Nesting usually takes place after the rainy season. The nest is no more than a scrape in the ground and sometimes a hoofmark or a dry cowpat is used. Two or three, sometimes four, eggs are laid and incubated by both parents. During the day the efficiently camouflaged eggs may be left to be warmed by the sun and when very hot the parents may shade eggs or chicks with outstretched wings. The chicks, which hatch out after 17–18 days, are at first fed by the parents and begin to feed themselves when about a fortnight old. They can run almost immediately and start to fly when 3 weeks old.

Pretended massacre

When approached on the nest pratincoles sit tight. Then, when dislodged, they fly to and fro calling. They also resort to distraction displays which are all the more impressive because a number of pratincoles display at the same time. The display takes the form of 'broken wings' and descriptions have been given of mass displays in which 20 or so pratincoles fluttered to the ground, thrashing about with one or both wings trailing, presenting a pitiable sight as if a shotgun had been discharged into the flock. No doubt the sight is sufficient to distract any predator from looking for the well-camouflaged eggs and chicks.

class	**Aves**
order	**Charadriiformes**
family	**Glareolidae**
genera & species	***Galachrysia nuchalis*** *collared pratincole*
	Glareola pratincola *pratincole*
	G. nordmanni *black-winged pratincole*
	Stiltia isabella *Australian pratincole, others*

◁ *Among the daisies—pratincoles do not build a nest, but lay their eggs in a shallow hollow in the ground, a hoof mark or even a dry cowpat.*

△ *Though pratincoles usually feed in the air they will visit short burnt off grassveld to feed on insects normally hidden in the long grass.*

▽ *A harassed pratincole gets ruffled as an intruder approaches its eggs in a field of grass and* ***Salicornia****.*

Eric Hosking

Prawn

Although this name has no scientific standing, scientists still use it. Originally it referred to one species that lives around the coasts of Europe and it continued this way for 500 years or more. Then gradually, as more and more marine animals were studied, the name was applied to all sorts of long-bodied, small crustaceans. Some of these will be considered at the end of this article.

The original prawn ***Palaemon serratus,*** *often called* ***Leander serratus****, is a large shrimp-like crustacean, about 2½ in. long excluding the antennae, with a sabre-shaped head shield that is toothed or serrated. The first and second pairs of legs have small but distinct pincer-like claws. The outer skeleton is thin and horn-like in texture and there are two pairs of very long filamentous antennae in front. The first pair has three branches, one extending forwards, the other two upwards and backwards. The other pair of antennae are undivided. The eyes are stalked. There are five pairs of limbs on the thorax, including the two bearing pincers, and five pairs of small swimming legs on the narrow abdomen, which ends in a fanlike tail.*

Three ways of moving

Prawns live inshore, on sandy bottoms over which they walk gently forward on the rear three pairs of thoracic limbs. They can also swim gently using the abdominal swimming legs or dart suddenly backwards by flexing the abdomen sharply under the thorax. This way of swimming is typical of all shrimps, lobsters and other close relatives of the prawn. Like so many other crustaceans, including crabs, prawns are scavengers, eating any small pieces of dead flesh that they find. They probably also eat small fragments of the various kinds of seaweed.

Climbing out of the old skin

Because of its external skeleton, or shell, which holds the body like a straitjacket, a crustacean cannot gradually grow in size but must do so in stages, with a moult at each stage. As with other animals growth is more rapid when young and slows down with age. The period between moults may be days, weeks or even months, the time varying with the species and with its age. Having fed for a while and stored enough energy to grow to a larger size the prawn grows a new 'shell' under the old one. In a mature prawn this takes about 2 weeks. The shell then splits across the back, where the abdomen joins the thorax. The front part is lifted up while the prawn pulls its legs out of its old covering, drags its abdomen free, then gives a sudden upward jump out of its old shell which lies empty on the sand, like a ghost. While the new shell is still soft the prawn takes in water which makes the body swell up stretching the new shell which later hardens. There is then room inside this new shell for more growth. The shedding of the old shell takes 10–20 seconds. The hardening of the new shell takes 2 days, and during this time the prawn hides as it is very vulnerable to predators.

Mating while moulting

Moulting time can also be mating time. In early summer, when her ovary is ripe, the female moults. While her new shell is still soft the male pairs with her, placing his sperm on her underside near the bases of the third pair of thoracic limbs. The two ducts from the ovary open here and the female, resting on her fanshaped tail and on the tips of her thoracic limbs, arches her body then lays her eggs. These are fertilised by the sperm as they stream out, and are swept back under the abdomen by the first pair of swimming legs. The other swimming legs, except for the last pair, secrete a cement-like substance from glands near their bases which glues the eggs in a mass to bristles on the female's underside. Although spawning takes only a few minutes, getting the eggs in position and glueing them takes an hour. The female when carrying the eggs is said to be in berry. Some days later the eggs hatch and the tiny larvae swim away, becoming part of the plankton for a while before changing into young prawns.

▽ *What a stunner!* ***Alpheus glaber*** *a snapping prawn stuns its prey with its large claw. The movable part is turned backwards and secured like the cocking of a gun. When a small fish passes the prawn's burrow, the catch is released with a 'crack' and the prey lies stunned.*

DP Wilson

Many enemies

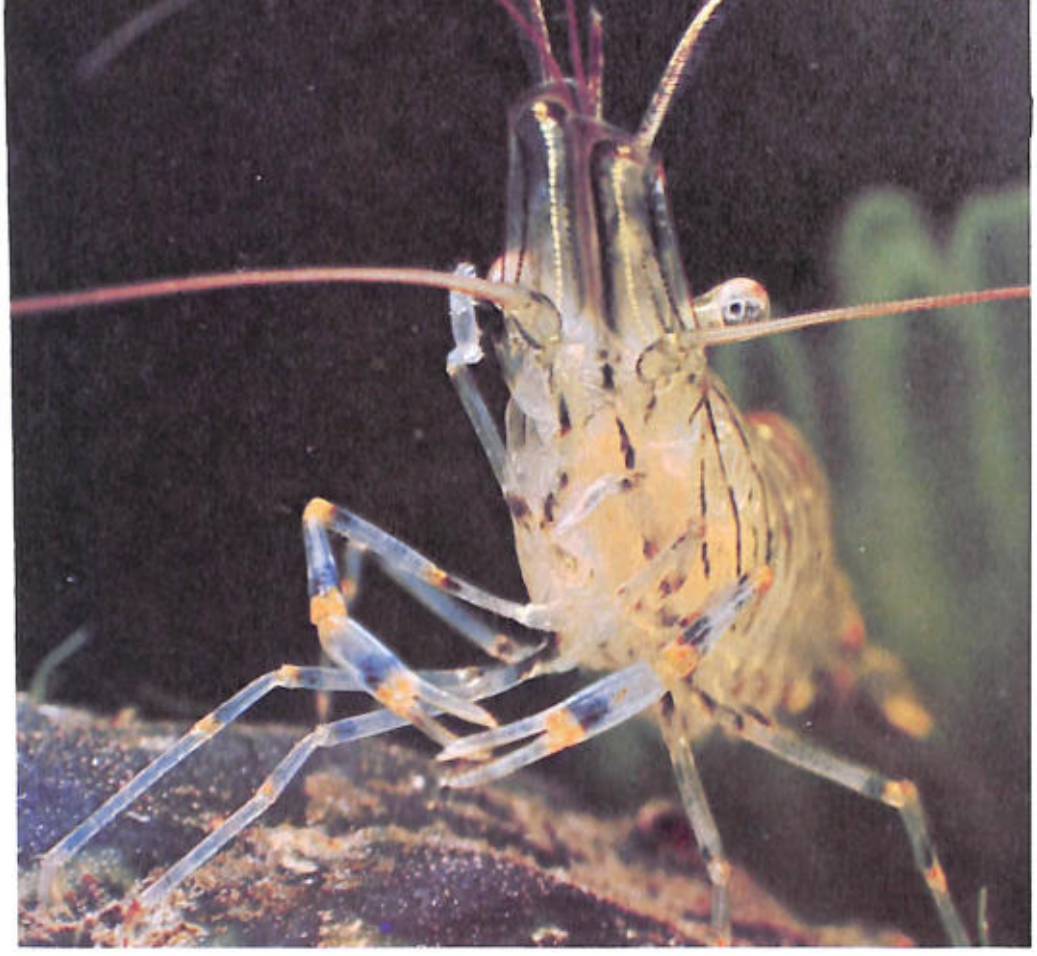
Prawns are highly acceptable to the human palate and so for centuries have been netted for food. Man is, however, only one of their many substantial predators. Almost any bottom-feeding animal is likely to include them in its diet but one of the prawn's main enemies is the cuttlefish.

Coloured flashy prawns

One of the most colourful prawns is the Aesop prawn *Hippolyte varians*, sometimes called the chameleon prawn. Aesop was a hunchback, and this prawn has a hunched back. When on green seaweed it is a bright green. On brown seaweed it is olive brown; on red seaweed it is red. At night it goes blue, no matter what coloured surface it is on. When an Aesop prawn is displaced it tries to find a seaweed the same colour as itself to perch among. If forced to stay on a seaweed of a different colour from itself it will change its own colour to match that of the weed; but it may take as much as a week for the colour change to be completed. The change in colour is controlled by the light entering the prawn's eyes. Glands in the eyestalks send a hormone into the blood which acts on the pigment cells. So, for example, a prawn coloured green when placed on a red seaweed receives red light rays into its eyes which make the hormones stimulate the red pigment cells in its skin.

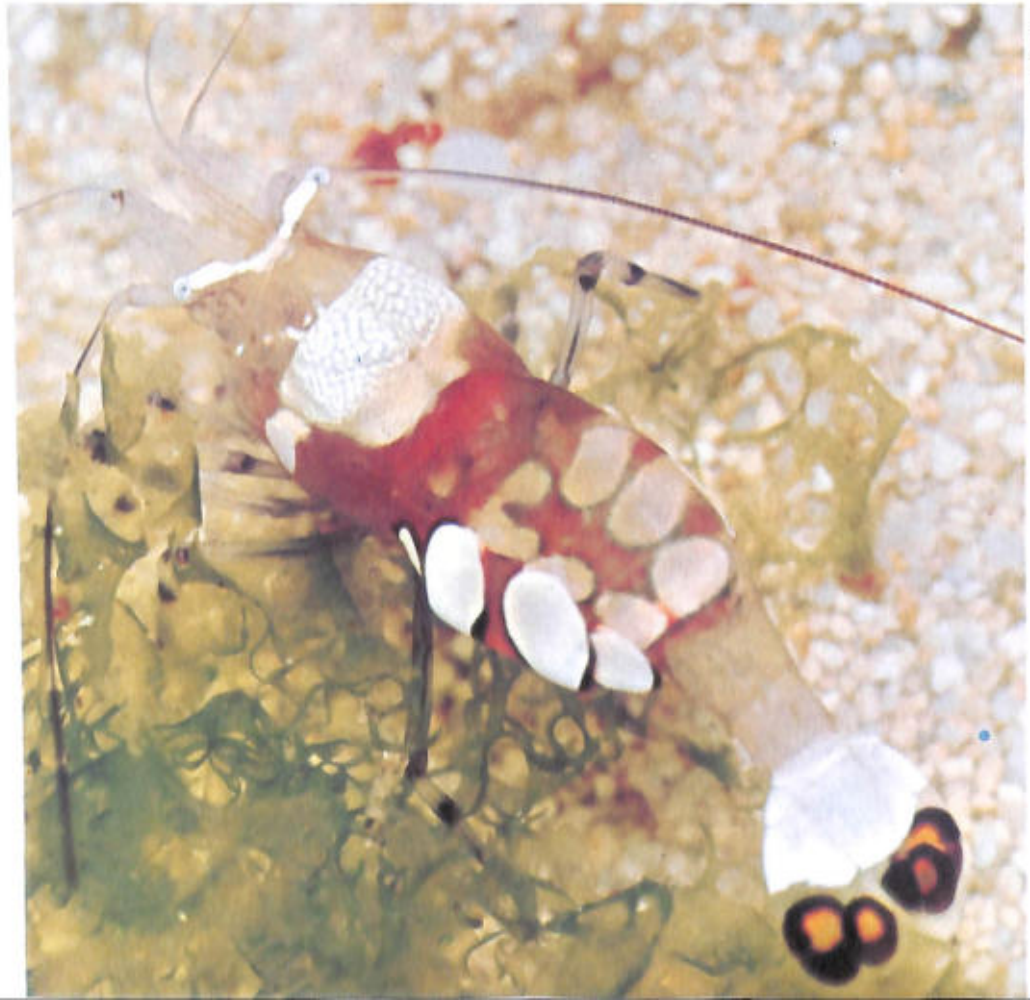
Prawns living in tropical seas may be a foot long, and deepsea prawns, living 1 500 ft down, may be nearly as big, and are vivid scarlet. Other deepsea prawns carry light organs which give out a greenish-yellow light. One of these *Sergestes prehensilis* has more than 150 light organs along its sides, like portholes on a ship. The prawn may flash them all on at once, switching them off just as suddenly, or they may light up one after another from head to tail, like a neon sign.

phylum	**Arthropoda**
class	**Crustacea**
order	**Decapoda**
family	**Palaemonidae**
genus & species	***Palaemon (Leander) serratus*** *others*



Jane Burton: Photo Res

△ *Common prawn of the deep—carefully cleans an antenna with one of its thoracic limbs.*
▷ ***Palaemon,*** *the common prawn, plays at king of the castle on a rock as barnacles feed below.*
▽ *Piebald prawn—the handsomely marked* ***Periclemenes brevicarpalis*** *is a tropical type found in association with the sea anemone* ***Discosoma****. Other animals associated with* ***Discosoma*** *have similar colour patterns. Unfortunately the significance of the pattern and the relationship is not yet known.*



Peter Hill

JAL Cooke

Prion

Prions are birds of the open ocean, coming to land only to breed. Small relatives of the fulmar (p. 985), there are about 6 species all living in the southern oceans. They are slate grey above and white underneath, with a prominent white stripe above the eye and a dark patch just below the eye. The upper surfaces of their wings are darker than the body and appear as a 'W' when prions are in flight. The bill has the tubular nostril, typical of the petrel family which includes the albatross, and in two species is fringed each side by a row of lamellae like a short-toothed comb. The tail is wedge-shaped. The legs and webbed feet are pale blue.

The largest prion is the broad-billed prion, 12 in. long. The bill has a black tip, the lower half having a black line running along the side. It is very broad at the base, like the bill of a frogmouth or potoo and gives the prion a very frog-like appearance. At the other end of the scale is the fairy prion, 9½ in. long, and the narrow-billed prion. The different species of prions cannot be distinguished in flight, and in the hand the main difference is in the shape of the bill. At sea they are easily confused with the blue petrel ***Halobaena caerulea.*** *The prions have wedge-shaped tails with black edges to the central feathers while the blue petrel has a square tail edged with white.*

Prions breed from the coasts of Australia and New Zealand to Cape Denison on the mainland of Antarctica due south of New Zealand. They are also found on the islands surrounding Antarctica, and as far north as Tristan da Cunha and Chatham Island. Outside the breeding season they fly northwards, occasionally reaching Madeira and Indonesia.

Ocean flocks

Prions travel in flocks over the ocean, flying swiftly and sometimes showing up well as they flick from side to side exposing their white bellies. They are often seen from ships in southern seas but they appear to be less common than they really are because their dull plumage blends so well with the sea, especially in Antarctic seas where visibility is often poor. The non-breeding season is usually spent well away from land and, apart from some shore feeding species, they are seen only in winter when storms blow them towards land.

Filter feeding

Prions congregate to feed where upwellings or mixing of the sea cause an abundance of planktonic animals and plants. The various species of prion appear to feed in different places, each exploiting a different source of food which prevents competition.

Food is picked out of the sea either by short dives, in which they submerge completely, but not for such a long time as diving petrels (p. 778), or by ducking the head and neck under the surface. This last they can do either while sitting on the water or while 'hydroplaning', running over the water with wings stiffly outstretched. Two species of prions are known to seamen as whalebirds and they are well named because the lamellae on the bill act as strainers in the same way as the whale's baleen plates. They take in a mouthful of water then squeeze it out between the lamellae leaving any plankton behind. The shape of the bill appears to be important in the separation of feeding habits. In New Zealand waters, for instance, the broad-billed prion feeds mainly on minute organisms. The lower part of the bill is pouch-like, and drops down allowing a large mouthful of water to be taken, like the lowering of the floor of the mouth by a blue whale (p. 384). The narrow-billed prion, on the other hand, feeds on crustaceans up to ½ in. long, which can easily be taken with its narrow bill.

▽ *Broad-billed prion outside its nesting burrow.*

MF Soper

Nesting in burrows

Prions nest in burrows that they dig in the soil, under tussac grass or in deep banks of mossy peat, but where the soil is scant or missing, they nest in crevices or under boulders. The burrows, up to 6 ft long, are dug with the bill, the feet being used to kick the loose soil out.

Nesting begins in the spring when the prions start visiting their old burrows or digging new burrows at night. At this time the air around the cliffs and slopes where they breed is filled with a continuous chorus of dove-like cooing as courtship takes place. After mating and digging the females leave the burrows for a few days for intensive feeding, extra food being needed to build up the single large egg. The egg is usually laid the night they return from feeding and is incubated for about 45 days, each parent sitting for 3–4 days at a time. The chick starts life as a ball of light grey down and is brooded for 3–5 days. When it is hungry it nibbles a parent's breast feathers and calls in high-pitched cheeps. The parent then regurgitates food and the chick puts its head in the parent's mouth to take it. The chicks leave the nest when 6–7 weeks old.

Dug out or frozen in

The main enemy of prions is the skua, the large gull-like predator, which feeds on penguins (see adèlie penguin, p. 19), and other sea birds. It is unlikely that it catches many prions in flight, but waits for them as they land and shuffle towards their burrows. Skuas also dig open the burrows to get at adults or chicks and the ground around a skua's nest may be littered with bones and feathers – the remains of prions.

In the Antarctic prion eggs and chicks are often endangered by the weather. If a snowstorm covers the burrow the parents can dig down to it, unless repeated thawing and freezing have left a hard crust over the entrance. Some burrows are liable to be filled with drift snow or melted water, which kill eggs and chicks by freezing.

Ideal colouring

In the First World War the American naval authorities were looking for suitable colours to paint warships to make them hard to detect by submarines. They wanted to find a colour that merged well with sea and sky. Robert Murphy, the American expert on oceanic birds, pointed out that prions seemed to have the ideal colouring, but the authorities decided to find a suitable colour by experiments. They eventually found the best camouflage colour was 'Omega grey'. Murphy then asked them to analyse the colours of the dove prion's plumage. It was almost identical with 'Omega grey', with a wavelength of 485 mμ against 'Omega grey's' 486 mμ. Whatever else can be seen from this story it shows that the difficulty of seeing prions as they flit over the waves is not just an optical illusion.

class	**Aves**
order	**Procellariiformes**
family	**Procellariidae**
genus & species	***Pachyptila belcheri*** *narrow-billed prion* ***P. desolata*** *dove prion* ***P. turtur*** *fairy prion* ***P. vittata*** *broad-billed prion* *others*

PH Ward

Unspectacular adults that have remarkable larvae, male (above) and female processionary moths, ***Thaumetopoea pityocampa****. Note the male's plume-like antennae. In most moths these are used to locate the females, being sensitive to extremely low concentrations of the scent given off by the females (×4).*

Processionary moth

Also known as processional or procession moths, it is the caterpillars of these moths that have stolen the limelight. The caterpillars form processions which almost every writer on the subject has been so taken with that he has failed to say anything about the moth itself.

There are two species in southern Europe, the oak processionary and the pine processionary, and others in the Old World. The male of the oak processionary moth is just over 1 in. across the wings, the forewings brown-grey with dark bars, the hindwings grey with indistinct dark bars. The female 1¼ in. across the wings is lighter in colour. Both rest on bark during the day with the wings folded and fly among the tops of oaks at night from August to September. The eggs are laid on the trunks of oaks and the following late spring the caterpillars hatch out. They are dark bluish-grey, whitish on the sides with rows of rusty-red hairy warts on the back and they grow to 1¾ in. The caterpillars spin a communal web, usually at the base of a tree, and go out at night in a procession to feed on the oak leaves. They pupate at the end of June in the communal web, the brownish pupae forming tight groups.

The pine processionary moth is similar but 1½ in. across and is on the wing from May to July. The eggs are laid on pines. The caterpillars are 1½ in. long, greyish-green with a dark back stripe and yellowish-red warts. The caterpillars cluster by day but have no permanent communal nest and they pupate individually deep in sandy soil.

△ *Gathering of pine processionary caterpillars. These larvae feed on pine shoots, sometimes to the extent of becoming a pest.*

We-ha

▽ *An orderly troop of* ***Ochrogaster*** *larvae. It is from this unusual 'follow-my-leader' habit that the adult moth gets its name.*

Graham Pizzey: Photo Res

Round and round interminably

The habits of the processionary are best illustrated by the well known story told by the famous entomologist JH Fabre. He persuaded the leader of a line of caterpillars to walk onto the rim of a tub 5 ft in circumference. When enough caterpillars were on the rim to form an unbroken circle he removed the rest and he cleaned away the trail of silk they had left behind. Steadily marching round and round the rim, the head of each touching the rear end of the one in front, the caterpillars continued for 8 days until some of them, either from exhaustion or accident, fell from the rim and the spell was broken. They had circled 335 times, stopping at intervals for a rest.

Two kinds of processions

The pine processionary travels in a single line and as many as 300 have been counted stretching for 40 ft. The oak processionary travels in shorter groups with a single leader followed by two, then three and so on to make a wedge-shaped column. Each caterpillar lays a thread of silk as it goes, so the trail is marked by a substantial carpet of silk. This was the trail Fabre removed. It used to be thought that in some way the silk helped the caterpillars follow each other. This proved not to be so although the silk trail is used for returning to their communal web. Since the caterpillars are blind and are said to lack a sense of smell it is reasonable to suppose they merely have the impulse to push the head against the rear end of one of their fellows. If one of them is pushed out of line the whole procession stops until that one is back in its place, then all set off again. Apparently there is no question of a leader. It is quite accidental which one starts the procession, and any one of the column can act as a leader.

Nettle-backs

At first glance it would seem that this extraordinary behaviour must lay the caterpillars open to dangers greater than usual. They have, however, very subtle defences. First, we are told, they are sensitive to approaching storms and all make for their home web. Secondly, they have a rude surprise in store for living enemies. Along the back each caterpillar has 'mirrors' normally hidden by folds of the skin. These are the warts. When the caterpillar is alarmed the folds are withdrawn and the mirror is exposed. Its surface is covered with nettle-hairs, short hollow bristles with poison glands at their bases. Around each mirror are longer branched bristles which, when touched, brush against the nettle-hairs breaking them away from their moorings so they form a sort of poison dart: one of the many examples of chemical warfare in the animal kingdom. These tiny poison darts produce an intense skin irritation.

Breaking up the procession

In a letter to *African Wild Life* of September 1958, Brian B Hobbs described an adventure just north of Satara, South Africa. He saw a line of caterpillars crossing the road, each light brown, hairy and 1¼ in. long. Before he realized they were there he had driven over them. 'Those on the passenger side of the car continued moving into the grass, while those between the wheels remained where they were; those on the driver's side also ceased moving forward. In each case the leader of the last two groups kept nosing about, trying to regain contact with his fellow in front, who had been obliterated. His hind-quarters remained rigid and those caterpillars behind him remained quite still. It would appear they are all blind . . .' Hobbs remained on the spot for 20 minutes and the two leaderless sections still had not moved forward.

Meaningless circles?

The habit of the processionary moth caterpillar may seem odd to us. Indeed, to see a circle of these caterpillars moving endlessly round and round is one of the most comical sights imaginable. Yet in spite of the kind of hazard Mr Hobbs described, the follow-my-leader behaviour must have great advantage to the species. For one thing, by using the silk trails they lay down, and by following each other, these caterpillars are sure of reaching their feeding grounds and of returning to the security of their communal web after feeding. But what are we to say of the nymphalid butterfly *Atella phalenta* of Mauritius which flies in immense numbers to the east across the mountain Trou-aux-cerfs, then around the foot to the starting point in an endless ring that has no beginning and no end. Alexander B Klots, the American entomologist, remarks that this makes less sense than Fabre's processionary caterpillars—this is an understatement.

phylum	**Arthropoda**
class	**Insecta**
order	**Lepidoptera**
family	**Notodontidae**
genera & species	***Ochrogaster contraria*** *Australian processionary* ***Thaumetopoea pinivora*** *pine processionary* ***T. processionea*** *oak processionary, others*

Pronghorn

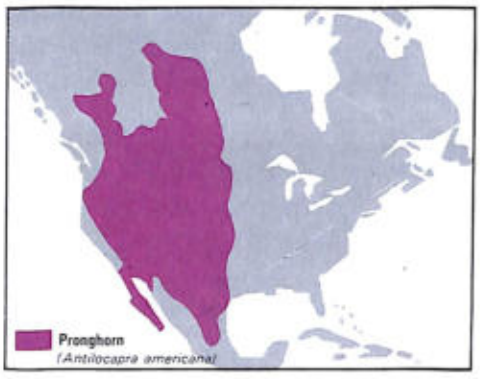
The pronghorn is the sole living representative of an ancient family that arose and developed in North America. Usually called the pronghorn antelope, it is not a true antelope, all of which are found in Asia and Africa. It stands 3½ ft at the shoulder and is 4½ ft in length with a 4in. tail. Bucks weigh about 140 lb, does 105 lb. The upper parts of the coat are reddish-brown to tan with a black mane and the underparts and rump white, with two white bands across the neck. The colour of the coat blends in well with its surroundings. It has large eyes, long pointed ears and a habit of allowing the lower lip to droop on one side giving it an odd expression. The buck has a black face and a patch of black hair on the side of the neck, characteristics which are less pronounced or missing in the female. Both sexes carry horns, which in the male are longer than the ears, consisting of a permanent, laterally flattened bony core, as in true antelopes, covered by a sheath of fused hairs. Like the antlers of deer they are shed annually, at the end of the breeding season, the bucks losing theirs first, the does shedding theirs a little later. The horns are erect, backward curving, and may be up to 20 in., averaging 15 in. The pronghorn gets its popular name from the short forward-pointing branch which is really part of the sheath, arising from the upper part of its horns.

The pronghorn lives in rocky desert and grassland in western Canada, the western United States and northern Mexico.

Venetian blind ventilation

The pronghorn can leap 20 ft at one bound. It is the swiftest mammal of the New World and cruises at a speed of 30 mph, and it is said to reach a speed of 50 mph over distances of up to ¾ mile. The woolly undercoat is covered by long coarse guard hairs which can be maintained at different angles by the flexing of certain skin muscles. Cold air is excluded when the hairs lie smooth and flat, but these can be raised to allow air movements to cool the skin in the heat of the desert sun. Cartilaginous pads on the hooves, particularly those of the forefeet, act like foam rubber soles, helping the pronghorn to travel quietly, as well as quickly. The forefeet are used to scrape holes in which to deposit droppings and to dig for food in snow-covered ground.

Grassland inhabitant: buck pronghorn antelope.



Winter nomads

The pronghorn eats a variety of low-growing grasses, shrubs, cactus and weeds and can if necessary get all the moisture it needs from this diet, although it will drink freely when water is available. The daily feeding range may be as much as 2 square miles. Except for the old bucks, which are sometimes solitary, pronghorns are gregarious and roam in small scattered bands throughout the summer. In winter they mass in herds of up to 100 or more and several times a year shift from one area to another in search of food.

Solitary birth

The rut begins in late summer when fights break out between the bucks. When the harems, which may consist of up to 15 does, have been collected, mating takes place, the season lasting 2–3 weeks. For a first birth there is normally a single fawn, but in later births twins or more rarely triplets are born. They are born after a gestation of 230–240 days. The doe seeks solitude for the birth, in open country with low vegetation. Young pronghorns are born with a wavy greyish coat, can walk within a few hours of birth and start grazing after 3 weeks. The coat breaks up the light, making the fawn almost invisible. By the age of 3 months the first adult-like coat has grown and at 15–16 months the does will mate although the bucks probably do not until about 2 years old. Pronghorns can live up to 15 years.

White for danger

Their main enemy is the coyote, especially in winter, for pronghorns cannot move quickly through snow. Bobcats will sometimes take the young. When danger threatens the hairs of the white rump patch are raised, alerting other pronghorns. This white flash can be seen by man over 2 miles away – and pronghorns have excellent distance vision. They are also very curious and will often approach an unfamiliar object, if not startled by a sudden movement or alarmed by its scent.

Curious pronghorn

The family Antilocapridae dates back 20 million years to the middle Miocene period in North America when the pronghorn population is estimated to have been 40 million. Hunting, for sport, trophies and meat, greatly reduced their numbers, which fell to 30 000 in 1925. Today, however, due to a policy of careful conservation, they are on the increase, the present population standing at about 400 000. Their acute inquisitiveness was noticed by the first pioneers who saw them, and this was to a large extent the pronghorn's undoing. It will inspect any moving object such as a bush waving in the wind or small dust devils raised by the wind, or anything unfamiliar such as dogs, goats, cattle or even machinery. An early trick used to attract the pronghorn was to push a stick into the ground and tie a white handkerchief on it which flapped in the wind. A man lying on his back and waving his legs in the air provided a similar attraction for bringing the pronghorn within gunshot. It seems that the pronghorn has learned its lesson. Today it may be just as inquisitive, but it satisfies its curiosity from a greater distance and is always ready to bolt at the slightest alarm.

class	**Mammalia**
order	**Artiodactyla**
family	**Antilocapridae**
genus & species	***Antilocapra americana***

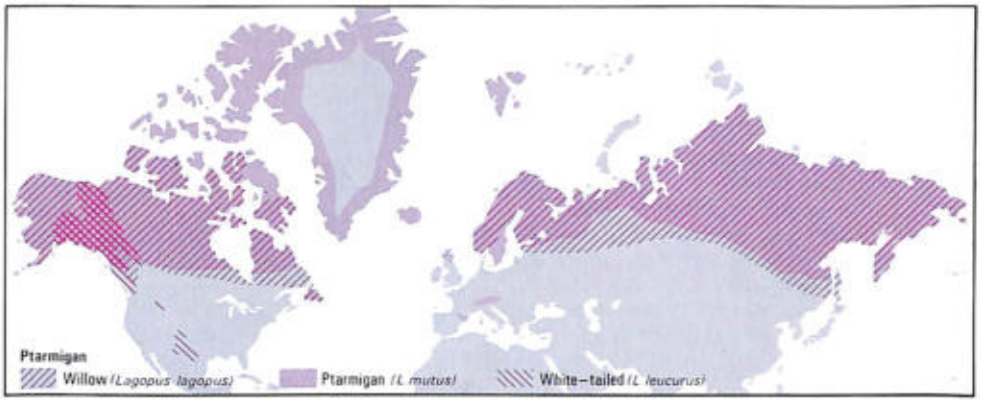
Winter wanderings: white-rumped pronghorns search for food in the snow-covered ground.

Joe van Wormer: Photo Res

Ptarmigan

The ptarmigan, 14 in. long, is distinguished from other grouse by its white wings and white underparts. There are three plumages—in spring and summer the cock has the upper parts mottled brownish-yellow and grey, the hen being more yellow with black markings; in autumn both are greyer, the hen being still lighter than the male, and in winter both are white all over except for the black tail, and the cock has black eye patches. The young ones have the parents' summer plumage except for dark primary flight feathers. The red wattle over the eye is larger in the male.

Ptarmigan range across northern Scandinavia, Siberia, Alaska, Arctic Canada, Greenland and Iceland with isolated populations in the Scottish Highlands, Pyrenees, Alps, Japan and Newfoundland. The willow ptarmigan, or willow grouse, is a related form with a more southerly range, in the lowland areas of Eurasia and North America. It sometimes interbreeds with the ptarmigan in the wild. The white-tailed ptarmigan is found in the Rocky Mountains, from Alaska to New Mexico, and is very similar to ptarmigan, often living alongside it but not interbreeding so is a distinct species.



Life among the rocks

Ptarmigan live among rocks with scanty vegetation at 2 000 ft or more in much severer habitats than their relative the grouse. When flying they rise over humps and dip into hollows and can shoot up or down a precipice with equal ease. They walk or run with a rounded back and their tail down, often with a rolling gait, although the cock is more inclined to strut. When alarmed they crouch, their plumage blending with the ground, and only fly away when danger is imminent. They sunbathe and dustbathe like other gamebirds, and roost in loose flocks. Family parties keep together until the autumn when several may come together forming fairly large flocks. In winter ptarmigan burrow in snow. The calls, a cough or croak, a cackling snore and, when uneasy, a call like a clock being wound, are distinctly unmusical. The female may even hiss at an intruder.

In summer they feed mainly in the early morning and in the evening, on shoots, leaves and seeds of saxifrage, chickweed, whitlow grass, mountain avens and mountain sorrel. Berries eaten include bilberry, bearberry, cranberry and similar fruits and a certain amount of insects are also eaten. The ptarmigan eats more leaves and shoots than the slightly larger willow ptarmigan with its more robust bill.

At the height of fashion, a cock willow ptarmigan in his new spring outfit. Versatile birds, ptarmigans have three plumages each year: one for spring and summer, one for autumn, and one for winter.

Chas J Ott Photo Res

Father only keeps watch

In spring the males display to the females by springing into the air with a sort of belching call, then dropping to the ground on outspread wings. They also chase the females with wings drooping and tail raised. The female makes the shallow scrape which serves as a nest among the short grass or low plants. At best it is lined with a few pieces of grass. In this nest 5–9 eggs, or as many as 16 at times, are laid at the end of May, at 24–48 hour intervals. They are pale yellowish-white with dark red or chocolate blotches. The hen alone incubates, when the clutch is complete, for 24–26 days, the cock keeping watch nearby. The chicks, brooded by the female and guarded by the male, can fly when 10 days old.

Distraction displays

There is little recorded information about the enemies of ptarmigan but it is reasonable to suppose they are preyed upon by birds of prey living in the same region. That they are also taken by ground predators, such as foxes, may be surmised from the behaviour of the hen in the presence of a dog. She uses much the same distraction display, or 'injury-feigning', when she has eggs or chicks, as do the other gamebirds; crawling along the ground with tail fanned and wings thrashing. When the young are off the nest she runs rapidly, flicking her wings to draw the dog away, then rises into the air when it gets near.

Ice Age relicts

The ptarmigan's unusual distribution, all around the Arctic with scattered populations on mountains farther south, is like that of a relict species. Whether they were able to survive the Ice Ages, in places as far north as Greenland, is impossible to say but they are clearly adapted to life in very cold climates. Their presence on the tops of the Pyrenees, Alps and other mountainous areas suggests they were widespread over the northern half of the northern hemisphere during an Ice Age and retreated north and up into the mountains as the ice cap retreated in the Interglacial period, when the warm climate spread north. The whiteness of the plumage, especially the winter plumage does more than serve as camouflage. It lowers the heat loss from the body. In winter the ptarmigan's ability to burrow under snow, and its possession of heavily feathered toes, acting as snowshoes, indicate that the species is adapted to cold conditions. Finally, there is a record of ptarmigan living at latitude 83 degrees 24 minutes N, in northern Greenland where it would have to endure 72°F of frost.

class	**Aves**
order	**Galliformes**
family	**Tetraonidae**
genus & species	***Lagopus lagopus*** *willow ptarmigan* ***L. leucurus*** *white-tailed ptarmigan* ***L. mutus*** *ptarmigan*

Even in June there is snow in Alaska, but this pair of white-tailed ptarmigans, male on the left, manage to merge well with their rocky surroundings.

Chas J Ott Photo Res

L Lee Rue III: Photo Res

From winter plumage and feather gaiters to summer brown for the ptarmigan (above). Silent travellers, willow ptarmigans in winter dress (below).

Popperfoto

Puff adder

There are 8 species of puff adder in Africa and they range in size from the Peringuey's desert adder, 1 ft long, to the Gaboon viper, 6 ft or more long. They are stout bodied snakes with short tails. The head is very broad compared with the neck, and is covered with small overlapping scales. There is a deep pit of unknown function above the nostrils, and in many species one or more erectile scales on the snout form 'horns', as in the rhinoceros viper. Not all puff adders are given this name, although they all belong to the same genus, and they fall into two groups. There are the highly coloured Gaboon viper and rhinoceros viper, of the tropical African forests, and the sombrely coloured brown and grey puff adders of the savannah and deserts. One of this second group, the common puff adder, is yellow to brown with darker bars or chevrons on the back. It ranges from Morocco southwards across the Sahara to the Cape and is also found in Arabia. The others have less extensive ranges, the Cape puff adder, for example, being found only in the mountains of Cape Province, South Africa.

Melting into the background

Savannah and desert puff adders, with their duller colourings, tend to harmonize with the differently coloured soils on which they are living. So also do the Gaboon and rhinoceros vipers in spite of their bright colours, for their colour patterns are disruptive. The Gaboon viper has a gaudy pattern of yellow, purple and brown arranged in geometric forms. The rhinoceros viper, even more brilliantly coloured with more purple, and blue as well, has green triangles margined with black and blue on its sides. But both snakes are virtually invisible on the carpet of dead and green leaves on the forest floor. The smaller species of puff adder live on sandy soils. Several of these smaller adders are able to climb into bushes, but generally puff adders keep to the ground, hunting mainly during the night.

Inoffensive yet deadly

The broad head of the puff adder houses the large venom glands and although the effect of this snake's bite is less rapid than that of a mamba or a cobra it is just as deadly. Fortunately, these snakes strike only to disable prey or in self-defence, and need a fair amount of provocation to make them hit back. Africans are said to be more afraid of harmless geckoes than of the Gaboon viper, and Herbert Lang tells of a small boy dragging a 5ft live specimen into his camp to sell it to him. If their venom is slow-acting it is nonetheless potent. R Martin Perkins, curator of reptiles in the St Louis Zoological Gardens, nearly died from the bite of a Gaboon viper. Some years later, in 1964, the Director of the Salt Lake City Zoo died from a puff adder bite received while handling the snake. Puff adders can give out as much as 15 drops of venom at a time—4 drops are enough to kill a man. But usually snakes give a first warning by hissing. The hissing sound is produced by forcing air from the lungs and windpipe through the glottis. Puff adders have an especially loud hiss. Their puff makes a sound more like the noise of a horse when it forces air through its lips.

Beckoning their food

The food of puff adders varies widely between the species. Small prey, such as a frog, is grabbed and swallowed without being poisoned. Larger prey is struck with the fangs and allowed to run away to die. The snake later follows its trail to eat it. The carcase is dragged into the snake's mouth by the teeth in the lower jaw. Once part of the victim has reached the throat, muscular swallowing movements carry it down, the snake holding its head up to assist this. Some scientists claim that the long fangs, which may be 2 in. long in a 5ft Gaboon viper, are used to drag the victim into the snake's mouth. South African herpetologists do not support this, but suggest the long fangs make it possible to inject the venom deeply.

The common puff adder and the Gaboon viper eat rats and mice, ground-living birds, frogs, toads and lizards. The Cape Mountain adder feeds on the same but is known to eat other snakes. The many-horned adder and the horned puff adder bury themselves in the sand, except for the eyes and snout, to catch lizards. The horned puff adder leaves the tip of its tail sticking out of the sand and waggles it to attract its victims within striking distance.

An enemy to many small animals, the puff adder has few adversaries itself, mainly birds of prey, mongooses and warthogs, and man. Puff adders can store large quantities of fat and this is sold by African herbalists as a cure for rheumatism.

Large families

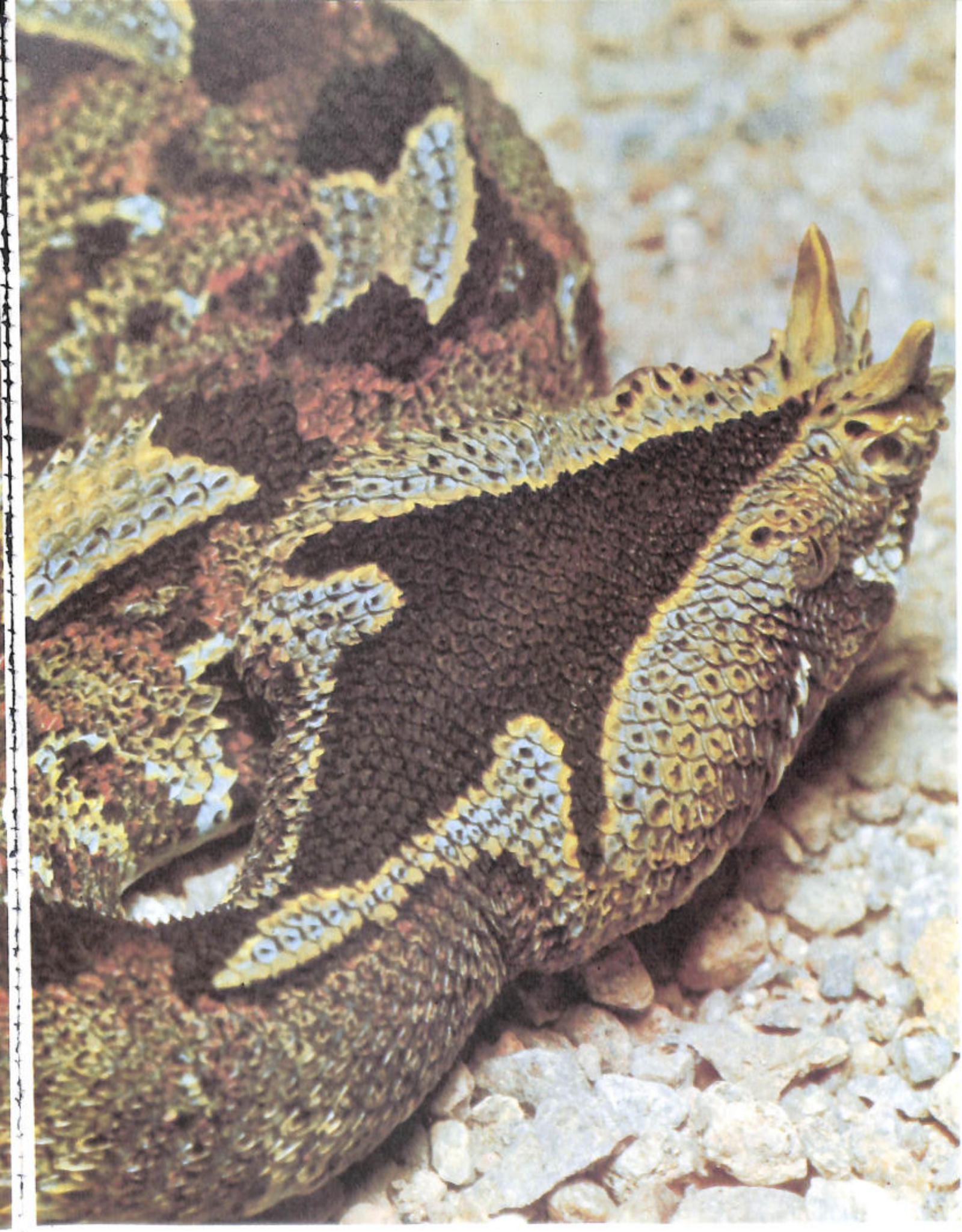
Puff adders are ovoviviparous. That is, the eggs are hatched inside the mother so the young are born alive or else they wriggle out of the egg capsule soon after it is laid. Mating is usually from October to December, the young being born in March and April. The young from a mother 3 ft long, are about 8 in. at birth. There are 8—15 in the litter of the smallest species, 70—80 or more in the large puff adders.

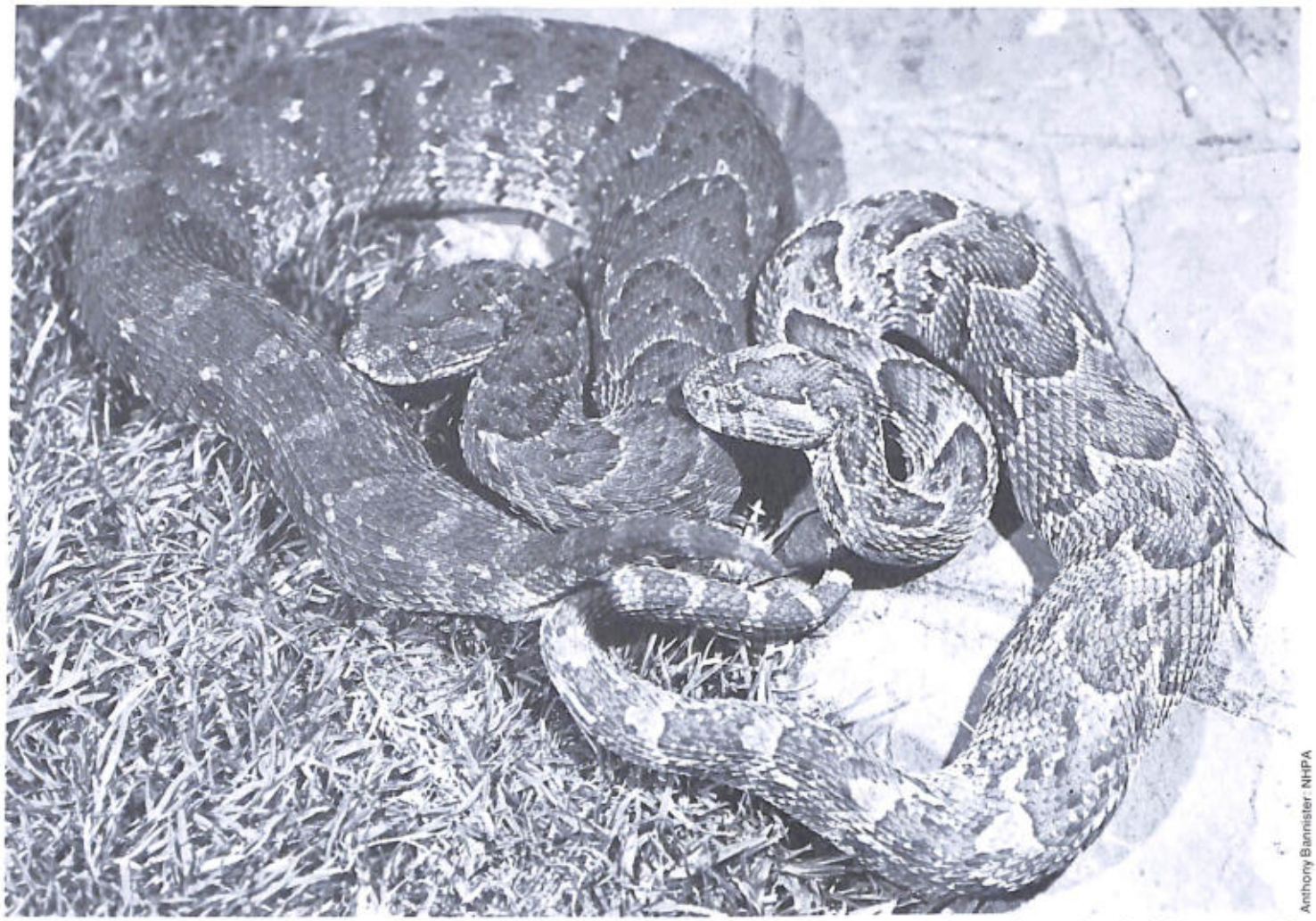
Fasting to grow

The paradoxical frog (p. 1838) is so named for the paradox that the tadpole is much greater than the froglet into which it changes. The puzzle is, where does all the spare flesh go? The situation is reversed in the baby puff adder. As soon as it is born it can kill and eat small mice although it moults first before looking for food. It can, however, happily go without food for as much as 3 months. The ability to fast is not unusual. What is extraordinary is that the baby puff adder still grows 25% in length and increases its girth by a quarter while doing so.

John Tashjian at San Diego Zoo

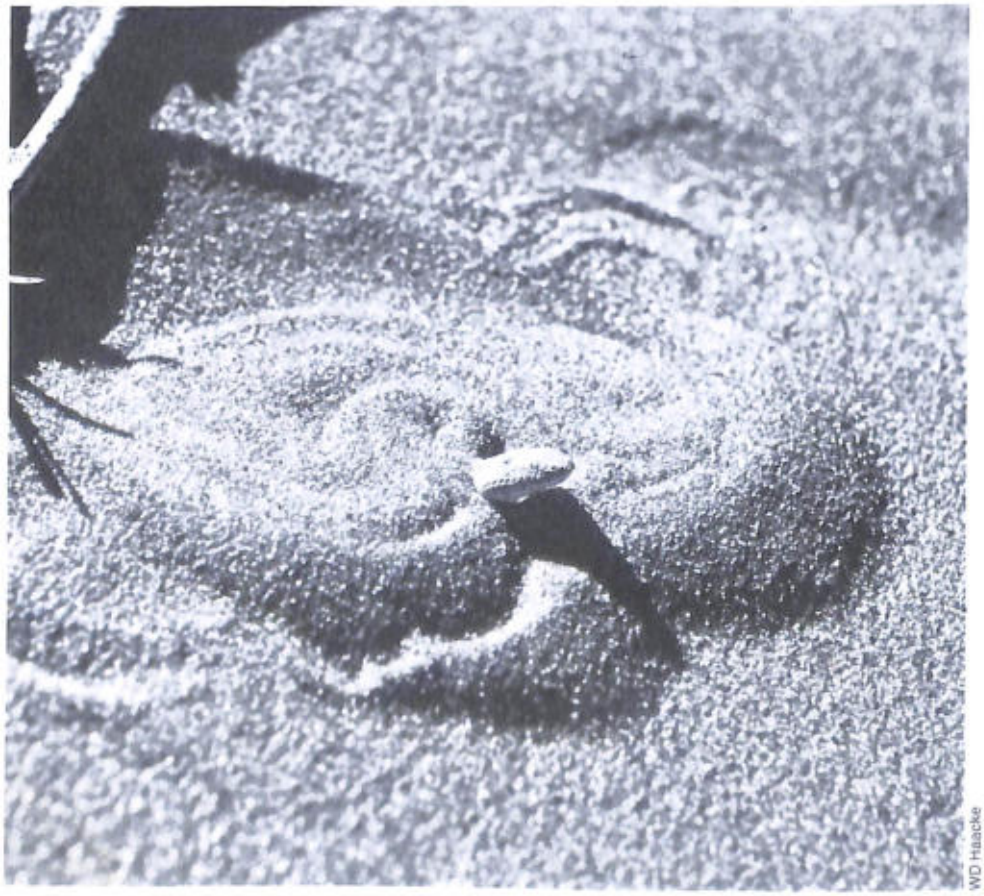
▷ *The attractive 'horned' head of the rhinoceros viper is deceptive; it houses the venom glands!*





Anthony Bannister NHPA

△ *Sedate mating, two love-locked common puff adders, the male is on the right. Mating usually takes place from October to December. Fertilisation is internal and sperm may survive inside the female for long periods. Most reptiles lay their eggs but puff adders are ovoviviparous, the female retains the eggs until the young are ready or nearly ready to hatch 5–6 months later.*



WD Hlatcke

◁ *Submerged for the day, a small Peringuey's puff adder spends the day well hidden. Alerted by the photographer the snake raises its head so giving its position away. But its sandy colouring blends well with the soil making the snake very inconspicuous.*

class	**Reptilia**
order	**Squamata**
suborder	**Serpentes**
family	**Viperidae**
genus & species	***Bitis arietans*** *common puff adder* ***B. atropos*** *Cape Mountain adder* ***B. caudalis*** *horned puff adder* ***B. cornuta*** *manyhorned adder* ***B. gabonica*** *Gaboon viper* ***B. inornata*** *Cape puff adder* ***B. nasicornis*** *rhinoceros viper* ***B. peringueyi*** *Peringuey's puff adder*

Puffbird

Their stout appearance, reminiscent of a puffin, and the loose, fluffy plumage of puffbirds has given them their aptly descriptive name. In Brazil they are known as ***João bobo*** *or Silly John in reference to their stupid appearance and sluggish habits, for they are very easy to approach. They are related to the woodpeckers and jacamars, having two toes on each foot facing backwards. The 30 species range from sparrow to jay size. The head is large, the bill hooked and the tail short.*

Most puffbirds live in the Amazon valley and surrounding low country, but three live north of Panama. The white-necked puffbird ranges from Mexico to the Amazon. It is 9—10 in. long, mainly black above with white underparts, forehead and collar and with a broad black band across the breast. Most puffbirds are, however, brown or grey with streaks and speckles. The white-whiskered softwing is a little smaller and ranges only as far south as Ecuador. It is chestnut-brown with tawny underparts, turning white on the belly, and a white patch on either side of the bill like a drooping moustache. The female is duller than the male. The swallow-wing has a similar build to these puffbirds but has long wings. It is like a stout swallow, about 6 in. long, and almost black with a white rump. Another group of puffbirds are the nunbirds, nunlets or monklets, so-called because of their plain dull brown and grey colouring, whose only relief is a bright orange bill.

Puffbirds live in forests, in low lying country. Some are found well up mountains living alone or in small groups. The nunbirds travel in small flocks.

Tied to a perch

Puffbirds appear very lethargic, perching motionless with their feathers puffed out, but they are in fact alert and pounce on any insect that appears. The swallow-wings can usually be seen sitting in pairs, on the bare branches of tree tops, from which they launch graceful sorties against insects.

Puffbirds are usually silent, uttering no more than a few soft whistles and peeps. They are very unwary, and will perch in exposed places, refusing to fly far if disturbed, as they often become very attached to their perches, sometimes using them year after year.

Snatching meals

The usual feeding method of puffbirds is to fly out from the perch, catch an insect and return, but they also snatch small animals from leaves and branches and a few descend to the ground for their prey. On returning to the perch the catch is pounded against the branch before being swallowed. Puffbirds' main food is large insects such as butterflies and locusts, spiders and sometimes lizards. They have been recorded as catching lizards as large as themselves.

JAL Cooke

White-necked puffbird photographed in Panama. The sharp hooked bill is typical of birds feeding on large insects and other small animals.

Underground nests and aerial nests

Puffbirds nest in holes which they burrow in the ground, or in the nests of tree-dwelling termites. The male and female black-breasted puffbird take turns to excavate a tunnel in a termitary suspended on a bough. The tunnel is about 7 in. long, 2 in. diameter, and widens into a nest chamber. The termites seal off their galleries from the puffbirds' tunnel so they leave each other alone.

Other puffbirds that have been studied make their burrows in the forest floor. They usually choose gently sloping ground. The white-whiskered softwing hollows out burrows 18—22 in. long. The nest chamber is lined with leaves and more leaves are placed around the entrance as camouflage. Swallow-wing burrows may be up to 8 ft long.

Puffbirds lay 2 or 3 white eggs which are incubated by both parents, but the incubation period is not known. The white-whiskered softwing has an unusual pattern of incubation. The male sits from late afternoon to the following dawn while the female sits only during the morning, the eggs being left unattended between these periods. The male broods the chicks for a few days while the female does all the feeding. When brooding has ceased the chicks seal the entrance to the nest chamber each night with leaves from the nest lining.

Hidden entrances

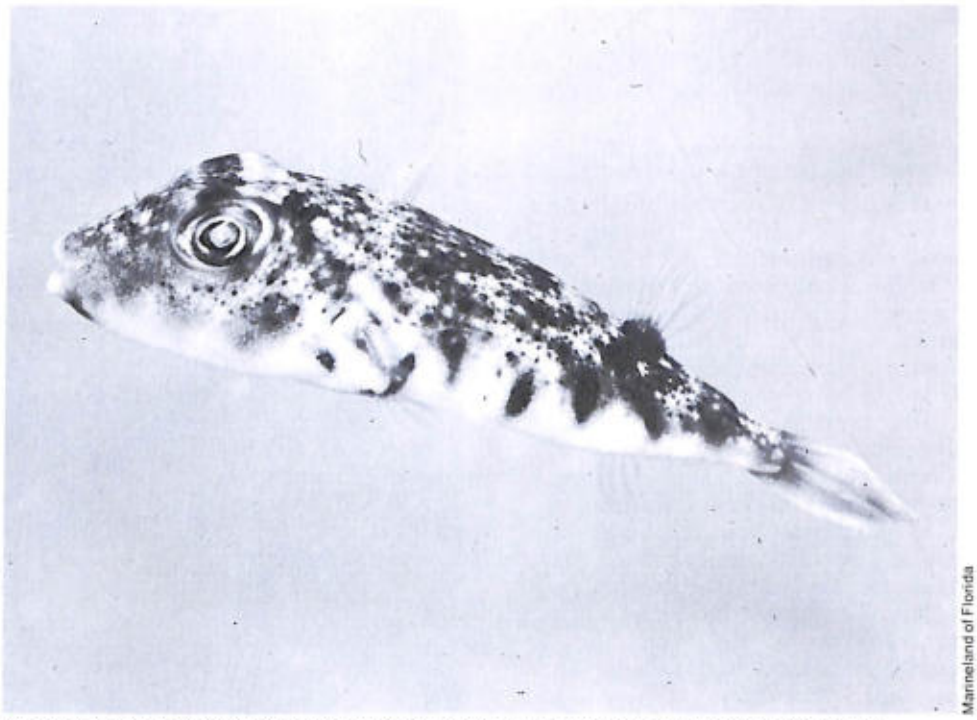
The burrow of the white-whiskered softwing is camouflaged with a collar of dead leaves and sticks which blends with the surrounding leaf litter; that of the black nunbird is hidden beneath a large pile of sticks with a tunnel in the side that connects with the burrow. The function of these structures is presumably to hide the nest from predators, for burrows in the forest floor are very vulnerable. Most burrow-nesting birds, such as kingfishers and martins make their burrows in the sides of steep banks where predators have difficulty in reaching them. The habit of the white-whiskered softwing nestlings of blocking the nest entrance is also a protection, as is their habit of keeping quiet and concealed except when being fed.

class	**Aves**
order	**Piciformes**
family	**Bucconidae**
genera & species	***Chelidoptera tenebrosa*** *swallow-wing* ***Malacoptila panamensis*** *white-whiskered softwing* ***Monasa atra*** *black nunbird* ***Notharchus macrorhynchus*** *white-necked puffbird* ***N. pectoralis*** *black-breasted puffbird, others*

Puffer

Puffers or pufferfishes are known by a variety of other names, such as balloonfishes, swellfishes, globefishes and blowfishes. All express their outstanding feature, of being able to blow themselves up to twice their normal size or more, like the related porcupine fish (p. 1965). They grow up to a foot or more in length. The body is flattened on the underside, rounded above, when in the normal state, with a large head and large prominent eyes that give an air of perpetual surprise—or of terror, according to the taste of the observer. The dorsal fin is set far back, with the anal fin immediately below it, and these, together with the pectoral fins, are used in swimming. The skin is tough with small erectable spines which take the place of scales. The belly is usually lighter than the back, but in some puffers it is white, while in others the colours of the back extend to the belly with only a slight difference in shade. Those species that live in the open sea are greenish or bluish black on the back. Those living around coral reefs are usually blue or purple brown with white spots, marblings or stripes.

They live in tropical seas, usually inshore among coral reefs, but several species go well up large rivers such as the Nile and Congo.



Marineland of Florida

△ *The marbled puffer* ***Sphaeroides dorsalis****, normal size, an ordinary small inoffensive fish.*

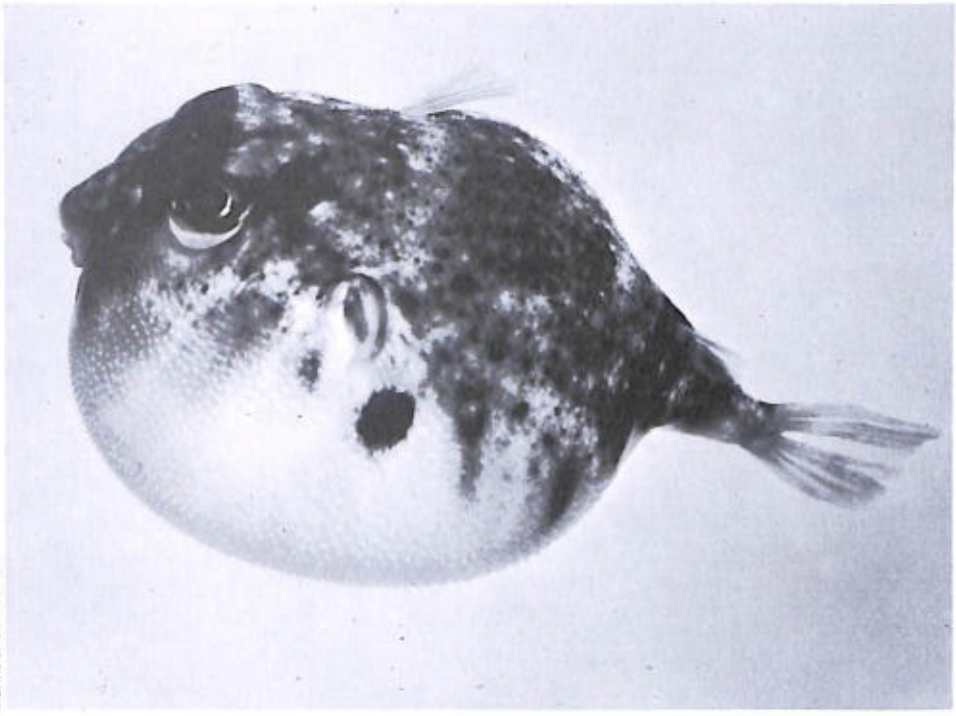
Unusual swimmer

The shape of these fishes is enough to show they do not swim fast. The gill capacity is low also, showing that they use little energy when swimming. They take prey that does not move or moves only slowly, and they rely for protection on their camouflage and the defensive measure of inflating the body. In fact, the swimming muscles normally found in the rear half of a fish have virtually disappeared but those working the dorsal and anal fins are strongly developed. A puffer swims by waving the dorsal and the anal fins from side-to-side, and this is helped by the pectoral fins. The tail fin is used only as a rudder.

Probably one of the most important items in the lives of these fishes, certainly the most striking to us, is their ability to blow themselves up. Strictly speaking, this is a matter of distending the belly. When in water an 8 in. puffer takes in as much as a quart of water. This is taken into a sac leading from the stomach and kept there by a muscular valve either side of it. When taken out of the water a puffer takes in air instead of water, by a swallowing action in which the floor of the mouth acts like part of a pump, being capable of considerable expansion and contraction. When swallowing air, the puffer makes a kind of gurgling uk-uk-uk noise.

Peter Hill

▷ *A fixed stare from a sharp-nosed puffer* ***Canthigaster margaritatus****. This small brilliantly coloured fish with its radiating blue lines is characterised by its long snout.*



Marineland of Florida

△ *The same marbled puffer, but now distended with water looking far more menacing and prickly.*

Rabbit-toothed shell crusher

The teeth of a puffer, like those of the porcupine fish, are fused to form a beak. In both upper and lower jaws they form a cutting edge in front and a grinding plate behind. A noticeable difference between the porcupine fish and the puffer is that the cutting portion of these dental plates has a cleft in the middle, giving the puffer, when its mouth is slightly open, a rabbit-mouthed expression. It is because they seem to have four teeth, two in each jaw, that they have been given the name tetraodon or 'four teeth'. The species living around coral reefs use these teeth to hack off pieces of coral. The coral is crushed and the living parts digested. Molluscs are crushed and swallowed, but puffers will eat any small, stationary or slow-moving animal, such as barnacles, sea snails, crabs, or worms. A number of puffers may group together to dismember a crab.

Precocious inflaters

Spawning takes place in late spring and summer. It is not certain, even for those few species in which anything at all is known of the breeding, whether the eggs are laid on the bottom or discharged and later sink. The eggs hatch in 4–5 days, and the baby puffers, ¼ in. long, can inflate their bodies almost from the time they are hatched.

John Tashjian at Steinhart Aquarium

Dangerous moments

Sharks and barracuda will eat puffers, in spite of their protective blowing up, but large fishes have been found with an inflated puffer impacted in the throat. Seabirds would have difficulty in eating a blown-up puffer. Therefore we can assume they have few enemies. However, it is highly likely, although we have no precise information on this, that puffers are vulnerable before they have had time to inflate and after they have deflated. As to this latter condition, there must be a time when muscle fatigue causes the puffer to get rid of the water it has taken in and return to normal size. It is probable, as with frogs and toads that inflate themselves as a protection against enemies, that some time must elapse before the inflation reflex again becomes fully operative. This would be another vulnerable period for the fish.

Poisoned food

The spiny skin and the inflatable body are the first lines of defence. Many puffers have a second line in the poison they carry. We have no information on how this affects animals eating the fishes, but a lot is known about the effects on people. Generally, puffers are among the most poisonous of all marine animals. Some of them carry one of the deadliest poisons in nature, known as tetraodontoxin (see newt, p. 1708). Not all species are poisonous and not all parts of the body carry the poison, which is usually located in the liver, reproductive organs, intestine, sometimes in the skin, and occasionally in the muscles. The poison from the poison puffer of the South Pacific is said to have been used by the Polynesians for tipping their spears. They call the fish *maki-maki*, meaning deadly death. Tetraodontoxin is a powerful nerve poison which can lead to rapid and violent death. Yet pufferfishes are eaten as a delicacy, known as *fugu*, in Japan, specially trained cooks being employed to prepare the fish. The main skill needed is to remove the liver and other poisonous parts without contaminating the flesh. Even so, there are still many deaths in Japan from eating this, and a Japanese saying, we are told, is: 'Great is the temptation to eat fugu but greater is the dread of dying.'

In the United States puffers taken in the nets were always thrown out as trash fish until it was found that the tail part of the northern puffer made delicious eating. It then became popular, in New York and Boston, as sea-squab.

class	**Osteichthyes**
order	**Tetraodontiformes**
family	**Tetraodontidae**
genus & species	***Tetraodon hispidus*** *Pacific puffer* ***T. maculatus*** *northern puffer* *others*

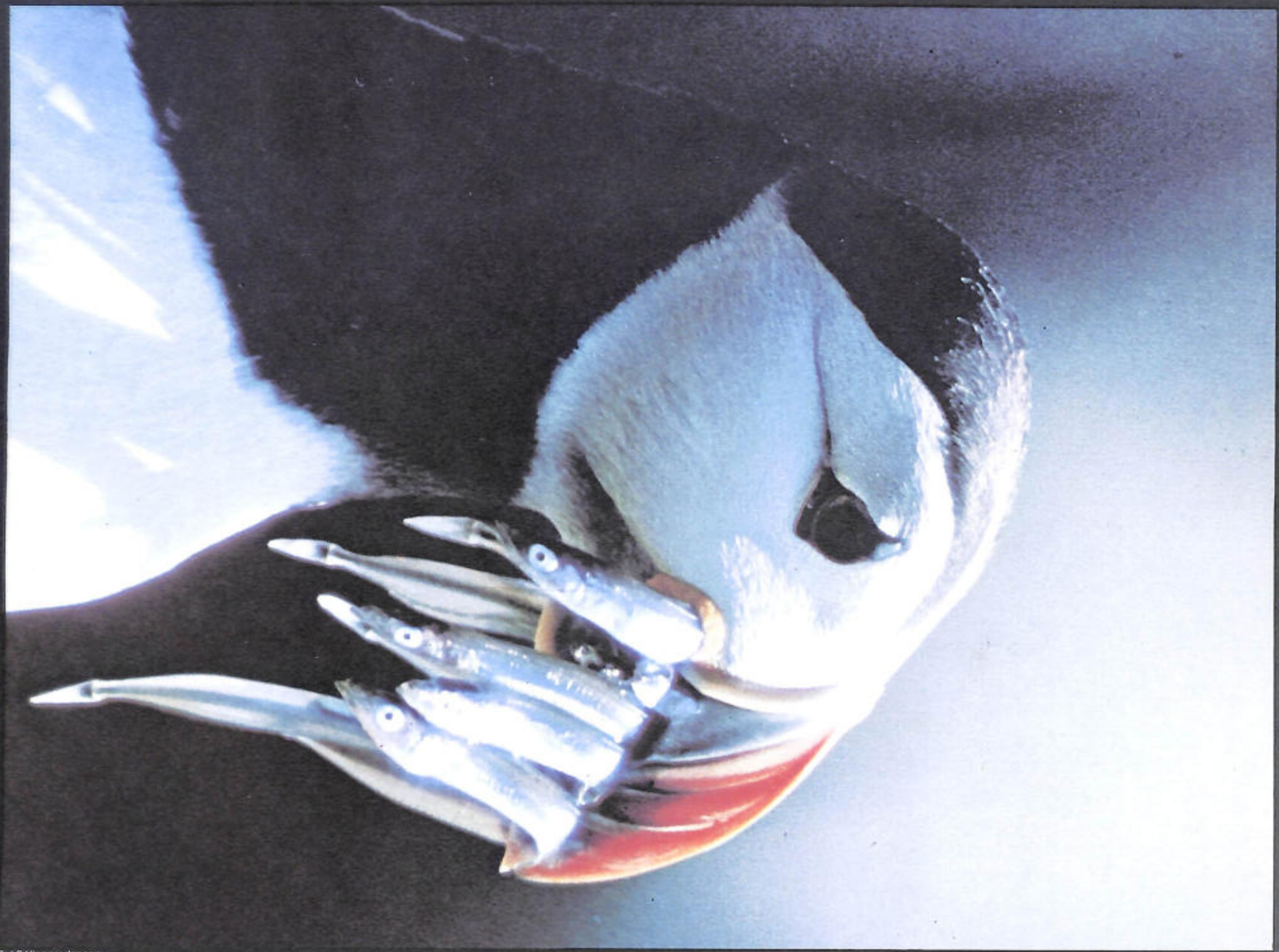
◁ *Polkadot fish. This wide-eyed youngster, a blue trunkfish* ***Ostracion lentiginosus*** *closely related to puffers, is just a solid bony box with holes for mouth, eyes and fins.*

Puffin

The puffin, a small auk about 12 in. long, with a massive, brilliantly coloured and decidedly bizarre bill, is perhaps the most popular and well known of sea birds. The comical effect of the bill is enhanced by coloured horny patches above and below the eyes. The plumage is basically the same as that of other auks; black above and white underneath, with the black extending around the neck as a collar. The legs are bright orange and the sides of the face ashy grey. The triangular bill has red, yellow and blue stripes with a thick yellow skin in the corners of the mouth. Outside the breeding season the basal part of the horny covering of the bill, including the blue parts and the yellow skin, are shed, leaving the base of the bill narrower and horn-coloured. At the same time the red tip becomes yellow. The bill of young puffins is more conventional, narrower and plainly coloured, the inner half greyish brown, the outer half reddish brown.

The puffin breeds along the coasts of the North Atlantic from Greenland to the Gulf of the St Lawrence in the west and from Spitzbergen and Novaya Zemlya to the British Isles and northern France in the east. Some spread as far south as the Canaries and into the Mediterranean as far as the Adriatic. British puffins have been found wintering in American waters but not all puffins migrate away from their breeding places. Puffins regularly spend the winter in Baffin Bay and in mild winters they stay near Amsterdam Island, north of Spitzbergen, despite the low temperatures and continual darkness of the Arctic winter. The horned puffin, which lives in the North Pacific and is a close relative of the Atlantic puffin, has fleshy growths over the eyes and differs in the colouring of the bill. It breeds on either side of the Bering Sea. Another Pacific puffin is the tufted puffin, all black but for a white face and long tufted feathers sprouting from above the eyes. The bill is red and green.

Bel G Vienne: Jacana



Bel G Vienne: Jacana

Comic sea parrots

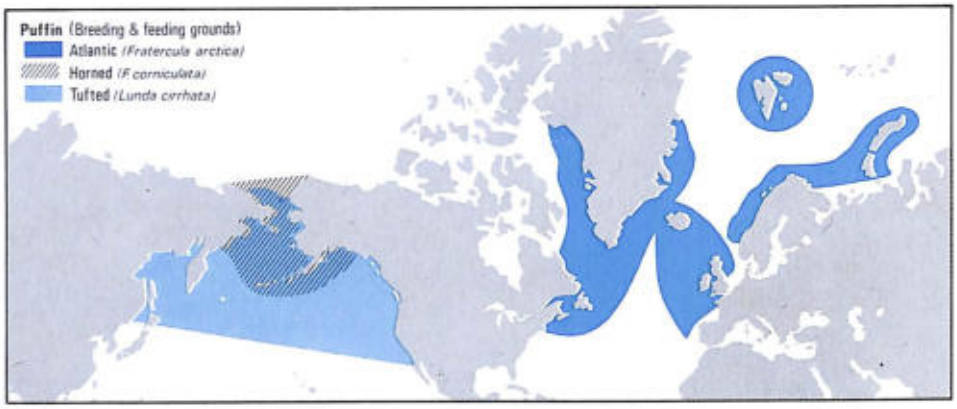
◁ *Captured in a puffin's beak, unfortunate sand eels glisten in the sun as the puffin pauses for a few moments to reflect on the glory of his catch, before flying back to his burrow to feed his young puffin. Puffins swim underwater with their wings while searching for food and are able to hold as many as 30 small fishes in their beaks, although this is rare.*

▷ *An affectionate peck. These two puffins are engaged in a ritualized courtship ceremony known as billing which may also occur during aggressive behaviour. Once they have mated on the water the puffins journey to a breeding ground where they begin either to dig a new burrow or clear out a disused one.*

▽ *A colony of puffins enjoy resting on a cliff at Farne Island. When they take off from the cliff the puffins' wings do not seem capable of supporting their squat bodies and they career steeply towards the sea until the rapidly beating wings come into effect and they rise. They spread their webbed feet as they turn corners while flying or coming in to land.*

G Ruppell

Harold Barnfather: Photo Res



▽ *Puffins scattered over the skyline come in to land at the breeding ground. Striking black and white faces, dominated by the brightly coloured beaks, peer out of burrows. These birds are always ready to display at their neighbours while they tediously sit on their eggs.*

Arthur Christiansen

Cliff nester

From spring until the end of the breeding season puffins contribute to the masses of auks that fly continually to and from the nesting cliffs. Instead of shuffling on their haunches like other auks such as the guillemots (p. 1120), puffins walk easily with a waddling gait. When they take off from the cliffs their wings appear to be too small to support them and they plunge steeply until their rapidly whirring wings become effective. When cornering in flight or coming in to land the orange feet are spread out to help in steering or braking.

Mysterious fish stackers

Puffins feed on small fish, such as sand eels and cod fry, together with crustaceans, floating molluscs and other planktonic animals. Outside the breeding season they go far out to sea, usually out of sight of land. Food is caught by diving, the puffins swimming underwater with their wings. If puffins have chicks to feed they carry their catch back in the bill. Puffins are quite tame on their breeding cliffs and can be watched from close quarters landing with fish draped crossways in the bill. They can carry up to 30 fish in this way, but this is exceptional. How they arrange the fish in the bill is still a mystery. Presumably each fish is killed by a nip with the bill but how it is then placed alongside ones caught previously without dropping them is difficult to visualize. The tongue and the serrated floor of the upper mandible may be used to manoeuvre and hold them. Pictures of puffins with fish arranged in the bill head-to-head or alternating head-to-tail are based on either imagination or coincidence. Working the fish into a pattern would be very difficult and would serve no useful purpose.

Slow development

When puffins arrive at the breeding ground they start digging burrows or clearing out old ones. They dig with their heavy bills and scrape the loosened soil out with their feet. In large colonies burrowing can be so extensive as to cause a landslide. Sometimes they take over shearwater or rabbit burrows.

Puffins arrive at the breeding grounds already paired but there is a considerable amount of displaying around the burrows. The large colourful bill is used as a signal, being thrust forward in threat or shaken in appeasement. Mating takes place on the water after the male has chased the female.

A single egg, white with faint markings, is incubated for 40–43 days. The parents share the task, but at intervals they leave the egg and parade together outside the burrow. The chick is fed on fish by both parents, but when 6 weeks old it is deserted by the parents who go out to sea to moult, during which time they become flightless. The chick stays in the burrow for another week then flutters down from the cliffs and paddles out to sea. The young puffins leave the burrows at night when there is less danger from gulls and skuas. Until they can fly they avoid danger by diving. Seven weeks is a very long fledging period for an auk, but puffins are reared in the safety of a burrow, whereas guillemots, razorbills and other auks breed on cliff ledges where their chicks are vulnerable to predation by gulls. These auks also leave the nest before they can fly, but unlike puffins are not independent and remain in the care of the adults.

Rat and oil problems

A certain number of puffins fall prey to gulls and skuas; on the island of Foula in the Shetlands, for instance, the cliffs are sometimes littered with the remains of puffins eaten by skuas, but their numbers are more severely reduced when rats are introduced to their breeding grounds. At one time the puffin population of Ailsa Craig was described as phenomenal, but in 1889, rats got ashore from a wreck and the population has since declined almost to extinction. A similar decrease has also occurred on Lundy, the name of this island being Norse for Puffin Island.

Recently there has been another threat to puffins, and other auks. Oil pollution is particularly serious to auks, because of their gregariousness and their habit of diving out of trouble and resurfacing in the oil patch. They are also particularly vulnerable when flightless during the moult.

Cliff crop

Man is another predator of puffins. The islanders of Faeroe, Shetland, St Kilda and other places have for a long time relied on sea birds for food, although the practice has declined in recent years. On St Kilda where sea birds formed the mainstay of the islanders, more puffins were killed than any other bird, including gannets and fulmars. They were the main food during the summer, eaten roasted, and their feathers were collected and sold. Catching puffins was usually the women's work, assisted by dogs who helped locate nests. They were hauled out of their burrows, snared or caught in nets as they flew in. On Foula, the sheer cliffs where many of the puffins nested were divided so that each man had a section where he could hazardously collect his crop.

class	**Aves**
order	**Charadriiformes**
family	**Alcidae**
genera & species	***Fratercula arctica*** *Atlantic puffin* ***F. corniculata*** *horned puffin* ***Lunda cirrhata*** *tufted puffin*

Puma

It is usual to say that this animal is known in Britain as the puma and in the United States and Canada as the cougar. Yet Stanley P Young and Edward A Goldman, American authors, have titled their book on it 'The Puma', and they claim this is the correct name for it. Probably no other animal has received so many common names, another of which is the mountain lion, which gives a clue to the appearance of the puma. It looks like a lioness, its coat is of short close fur and its colour yellowish-brown, although this varies from yellow to red. The maximum size recorded, for a male, was 9½ ft long, of which 3 ft was tail, and 275 lb weight, but there is much variation from as little as 4 ft total length and 46 lb weight. The females are generally smaller than males. The puma ranges from western Canada to Patagonia in the southern half of South America, on mountains, plains, deserts and in forests. Although there is only one species, 30 subspecies have been named, based on differences in size and colour, a clear indication how variable these two features are.

Powerful caterwauling killer

The puma is known for its remarkable strength and stamina. It will cover up to 20 ft in one bound and a leap of 40 ft has been recorded. It can leap upwards to a height of 15 ft and has been known to drop to the ground from a height of 60 ft. Like many other members of the cat family, the puma leads a solitary life keeping very much out of sight. A puma will often kill and, holding its prey, toss it over its shoulder and walk away with it; one has been known to drag a carcase three times its own weight over the snow. It will travel 30–50 miles when hunting. Its trail is marked by the remains of prey lightly buried in the ground, and by the scratchings where it has scraped earth over its urine or dung.

Some of its common names, such as catamount, refer to the puma's voice, but there are differences of opinion on how much this is used. Pumas are said to emit blood-curdling screams at times and there have been many vivid descriptions of this. It has been described as a weird caterwauling yell or scream, hence the saying 'to yell like a painter'—another name for the puma. By contrast, game wardens working in puma country for years have remarked on the fact that they have never heard a puma scream. It has even been suggested that people have seen a puma in a tree, for it is a good climber, and at that moment a great horned owl, hidden in the tree, has called and this has been credited to the puma. The evidence suggests that both male and female scream but not frequently. Normally they purr when contented.

A unique and magnificent action picture of a puma making a flying leap to the ground. This cat is renowned for its strength and stamina.

Another aspect of the puma's way of life which is much debated has to do with its attitude towards man. It has been represented as highly dangerous yet sober surveys show that attacks on human beings are so rare as to be negligible. It seems likely that the screaming may have contributed to an undeserved reputation for ferocity, together with its habit of stalking people. This seems to arise from an overwhelming curiosity and many naturalists have told how they have been followed by a puma which melts into the undergrowth every time they look round.

Controlling the deer

Its main prey is deer which may make up 50–75% of its food, and wherever the puma is killed off, deer multiply rapidly. It also takes a variety of small mammals including porcupines. It sometimes attacks domestic stock, such as sheep and goats, as well as horses and cattle, and it will take carrion. Ponies are said to be especially attractive to pumas. They stalk the larger prey, suddenly pouncing on their backs with a powerful leap, often with such violence that the prey is carried up to 20 ft along the ground. The typical method of killing is by a bite into the throat.

Spotted kittens

Pumas breed the year round. After a gestation of 90–93 days a litter of 1–4 cubs is born; at birth they are blind, and have spotted fur and a ringed tail. The eyes open at 10–14 days and the cubs are weaned at 1–3 months. The period seems to vary, as does the time they stay with the mother, which is up to 2 years. As they mature the cubs lose their spots and the rings on the tail. The life-span is up to 18 years.

Man the merciless enemy

A puma has few enemies apart from man but where their ranges coincide jaguars and pumas often fight. Wolverines will attack pumas and grizzly bears are also credited with doing so. These hazards are probably very trivial compared with man's activities which have wiped out the puma or seriously reduced its numbers in parts of its range. Pumas are killed with traps and hunted especially with dogs which will usually tree the puma putting it at the mercy of the marksman. In some places and at various times bounties have been paid, the main complaint against the puma being its attacks on domestic stock.

Puma: the friend of man

In contrast with the way pumas are persecuted in North America, these animals have been called 'the friend of man'. The origins of this title go back to 1536 when the Spaniards in Buenos Aires were at war with the Indians. A young woman, Senorita Maldonado, was wrongly accused of treachery when, in fact, she had been carried off by the Indians. She was condemned to be tied to a tree to be eaten by wild beasts. After two nights and a day the soldiers went to collect her bones for burial and found her unhurt. She explained that a puma had stayed by her and driven off the jaguars and other beasts that came to destroy her. The Indians of California had even more cause to regard the puma with friendly feelings. The Jesuit priests who went there to preach Christianity to the natives found that for centuries they had largely fed on the remains of the pumas' prey.

class	**Mammalia**
order	**Carnivora**
family	**Felidae**
genus & species	***Felis concolor***

Truce at mealtime. Fastidious as most cats are, the puma cleans a paw while the grizzly bear continues to eat the elk. Pumas have few enemies although grizzly bears are said to attack them. In fact the puma is a shy animal leading a solitary life hunting deer, small mammals and birds.

Dick Robinson Photo Res

Purple emperor

A large, showy and unfortunately rare butterfly, the purple emperor is named after the purple iridescence on the wings of the male, which can only be seen when viewed from a particular angle. Otherwise they are dark-brown, almost black, with a line of white patches and an inconspicuous eyespot on each hind wing. The white patches are very occasionally missing and such purple emperors are known as the variety ***iole****, much sought after by collectors. The underside of the wing has an intricate pattern of brown and grey with bands of white. The female is very much like the male but lacks the iridescence and is slightly larger. Her wingspan is 3 in. compared with 2½–2¾ in. of the males.*

Purple emperors are found locally in many parts of Europe and Asia. In Britain, they are restricted to a few places in the south.

GE Hyde

Brilliant beauty—a purple emperor sunning itself on a sprig of oak leaves. This attractive butterfly is, unfortunately, not very common and is seen even more rarely than one would expect as it spends most of its time at the tops of oak trees. Although it can survive in young oak plantations, mature oak woods are becoming fewer and fewer.

The butterfly's purple colouring, possessed by the male only, is normally seen on but one wing, as in this picture. In some lights both wings are iridescent, the purple scales changing colour with the incidence of the light. There are also dark scales caused by melanic pigment.

Two plants needed

Purple emperors' preference for oak woods is one factor which limits their distribution since these woods become scarcer year by year due to man's activities. Purple emperors do, however, survive in woodlands that have been stripped of all tall trees. They are on the wing in July and the first half of August but even in bright weather and in places where they are known to live they are not easy to see. They are not attracted to flowers like so many other butterflies and spend most of their time around the tops of oak trees. The dull coloured females are easier to find because they descend to lay their eggs in sallow bushes. The males spend their time perching on leaves and periodically flying high across a clearing or soaring up almost out of sight on their powerful wings. Sometimes several males may be seen chasing each other in circles.

Slug-like caterpillar

Purple emperors lay their eggs on the upper surfaces of sallow leaves. Each female ranges over a considerable area, laying one egg on each leaf, although she may revisit a bush later and so lay another egg on a leaf already bearing one. Other females may also use that leaf, so it is quite possible to find several eggs on one leaf. The egg is like a minute blancmange, $\frac{1}{25}$ in. high, almost hemispherical with about 14 radially arranged ridges. At first it is green, then the base becomes purple, and just before hatching it turns black. The caterpillar emerges about a fortnight after the egg is laid. It is yellow with a black head and measures just a little over $\frac{1}{10}$ in.

After 10 days of eating the sallow leaf on which the egg was laid the caterpillar sheds its skin. It is now green, the same colour as the sallow leaf, and it looks very much like a slug, with a pair of horns projecting from the head and a body tapering to a point at the rear end.

The caterpillar continues to feed through the summer and into autumn. It grows to ½ in. and changes to brown, so matching the autumn leaves. When not feeding it lies along the midrib of the leaf so that it is very inconspicuous. In October the caterpillar retires to a twig or a fork between two twigs, and spins a mat of fine silk on which it rests for the winter. In the following April the caterpillar changes colour back to green, and starts feeding on the fresh leaves, growing to 1¾ in. before pupating in June. Pupation takes place on the underside of the sallow leaf where it lays a mat of silk and runs more silk up the leaf stem to the twig, presumably to act as an anchor. The chrysalis hangs from the silk mat by a number of small hooks. Just before pupating the caterpillar changes to a very pale green, matching the underside of the sallow leaf, and making the chrysalis very difficult to find. The adult butterfly emerges in about 3 weeks.

Lured to the ground

Although male purple emperors spend most of their short lives in the tops of the trees, they do sometimes come down, feeding on the sap that oozes from wounded trees and sometimes on the honeydew of aphides (p 69). They also descend to the ground to drink at puddles or to feed on animal carcases or horse droppings. At one time purple emperors were caught by placing the rotting corpse of a rabbit or other animal in a woodland ride, but this method is not successful now, probably because the purple emperor has become so rare. They can also be attracted by bright objects and there are several stories of male purple emperors coming down to settle on car radiators, and even flying headlong into cars as they are being driven along.

phylum	**Arthropoda**
class	**Insecta**
order	**Lepidoptera**
family	**Nymphalidae**
genus & species	***Apatura iris***

Purple sea snail

Sometimes called the violet sea snail or the floating shell of the high seas, the purple sea snail is one of the most extraordinary of molluscs. It is shaped like a garden snail or a periwinkle, and resembles them both in structure. The body is purple and the shell, blue, lavender, violet or purple, is paper-thin yet not transparent. The mollusc lives more or less permanently upside down. The upper part of its shell, that is the part that is underneath, is whitish, so it is counter-shaded, like fishes with a coloured back and a whitish or silvery belly. The light-weight shell may be up to 2½ in. across but is usually smaller. Judging by the large quantities of their empty shells washed up on tropical beaches, purple sea snails live in very large numbers in the warm seas of the Atlantic, Indian and Pacific oceans. Sometimes the dying or dead animals are carried by warm currents, driven by persistent winds in summer, onto shores of temperate seas.

Bubble rafts

The purple sea snail, which forms part of the oceanic plankton, floats more or less permanently upside down at the surface on a bubble raft, which it makes by secreting, from the middle and front part of the foot, a kind of froth which traps the air into bubbles. The tip of this part of the foot is pushed out through the surface film. It closes round a bubble of air, almost as if it were a hand grasping, and brings this down to the middle of the foot to be coated with mucus. Although transparent the bubbles cannot be pricked open, their walls being hard and like a cuticle. After they have hardened they are glued together by having more mucus poured over them. The raft is usually 3–4 times the size of the sea snail.

Feeding on jellyfish

Purple sea snails feed on other animals in the plankton, such as crustaceans and jelly-fishes, the crustaceans including stalked barnacle larvae, and the jellyfishes including most notably that known as *Velella*, a relative of the Portuguese man-o'-war (p. 1970). *Velella* is made up of a colony of polyps hanging down from a plate-like float which is several inches across. On the upper side of the float is a nearly triangular crest, looking like a low sail. *Velella* has been called By-the-wind-sailor or Jack-sail-by-the-wind. We have definite information only about the way the purple sea snail feeds on *Velella*. It clings to the underside of the jellyfish and steadily eats away the polyps and the tentacles with their stinging cells, leaving in the end the plate-like float with its triangular sail to drift on the surface of the sea. These lifeless rafts are not wasted: barnacles often settle on their undersurfaces.

We know they eat copepods, and also another flattened disc-like jellyfish related to *Velella* and known as *Porpita*, as remains of these have been found in their stomachs. They also eat *Halobates*, the only marine insect which is a kind of pond skater. Purple sea snails also indulge in cannibalism, so it seems they just eat any kind of animal they can overpower. They have no eyes, the main sense-organ being a black tentacle near the mouth which may be an organ of smell by which the snails detect the presence of prey.

Table to cradle

As if to add insult to injury the purple sea snail lays its eggs on the undersurface of the cleaned-up *Velella*, converting a former dining table into a cradle. Most species lay eggs in capsules which are fixed in rows. They may also be laid on the undersurface of the bubble raft. The number of capsules may be 200–600 according to the species and the size of the individual laying the eggs. The number of eggs per capsule may be as few as 17 in one species and as many as 5 500 in another. The purple sea snail that most commonly reaches the shores of the British Isles gives birth to live young. These are ciliated larvae, known as veligers, and they are like the larvae that hatch from eggs. One curious feature of the veliger larva is that it has an operculum—like the winkle head (see periwinkle, p. 1877). Most land or sea snails have an operculum throughout their life, but the purple sea snail larva loses it when it changes to a tiny snail and it is not replaced. Young purple sea snails are male at first, becoming female later in life.

Oceanic Borgias

It had been noted a long time ago that while the purple sea snail is feeding it squirts out a violet dye from time to time. The importance of this was not realized until 15 years ago. This dye seems to act as an anaesthetic on *Velella*. Since some of the polyps, as in the Portuguese man-o'-war, are digestive polyps capable of fastening onto and slowly digesting another animal, we can presume the sea snail has to numb its prey. There are also the tentacles with their poisonous stinging cells to be reckoned with. Mr Peter David, of the National Institute of Oceanography, caught some *Velella* with snails on them, 500 miles out in the Atlantic. He kept them in an aquarium and watched the feeding. He also found that when *Velella* had been squirted with the purple dye by the sea snail it did not shed its tentacles as it died which is what it usually does. Moreover, when put into a preserving fluid the tentacles did not contract nearly as much as when the *Velella* had not been sprayed. The logical conclusion, therefore, is that the purple sea snail 'puts its victims to sleep' before devouring them.

Finally there is a slight touch of comedy-tragedy. The barnacles that settle on the dead *Velella* raft may be eaten by another purple sea snail. On the other hand the sea snail itself may be plagued by ship's barnacles that settle on its own shell.

phylum	**Mollusca**
class	**Gastropoda**
order	**Mesogastropoda**
family	**Ianthinidae**
genus & species	***Ianthina exigua***
	I. globosa
	I. janthina
	I. violacea

Life upside down – two living specimens of ***Ianthina janthina*** *float at the water surface attached to their permanent bubble rafts. The snail and its raft are carried along by sea currents and by the wind. Purple sea snails are often seen feeding in large numbers yet lone individuals seem to find enough of their favourite jellyfish* ***Velella*** *to eat; these are speared expertly by the snail's long prehensile proboscis. The snail on the left is shedding a violet dye which is thought to anaesthetise its victims before they are devoured.*

FEATURED IN THIS VOLUME

Piranha
Plankton
Pointer
Polar Bear
Polar Environments
Poodle
Portuguese Man-O'-War
Puma