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FEEDING OF THE SILVER GULL, *LARUS NOVAE-HOLLANDIAE*, ON THE BLOWFISH, *SPHEROIDES PLEUROGRAMMA*

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INTRODUCTION

Most of the Tetraodontidae (blowfish, toadfish, etc.) are extremely poisonous. However some birds and some fish do prey extensively on them and are not affected by the poison. The common local Blowfish, *Spheroides pleurogramma* (Regan), is a known poisonous species but observations have revealed that it can be safely eaten by the Silver Gull, *Larus novae-hollandiae* (Stephens), and that it forms part of the Silver Gull's diet. This has been confirmed by experimental feeding.

An account of these observations and experiments is given in the present article, together with other relevant information.

OBSERVATIONS ON GULLS AND BLOWFISH

During many years of bird-watching I have frequently seen Silver Gulls "playing" with Blowfish and have flushed birds from the partly eaten bodies of this fish at Pelican Point, on the Swan River estuary, and its immediate environs.

Miss C. A. Nicholls has also seen Silver Gulls "playing" with Blowfish at Pelican Point, has noted partly eaten bodies of Blowfish there, and has seen gulls in possession of Blowfish which were little more than head and skin. Both Miss Nicholls' observations and my own would have been mostly in the summer months (approximately October to February).

I have recorded the death of an immature Silver Gull which had swallowed a Blowfish at Pelican Point in September 1963 (Stranger, 1964) and in September 1968 I saw two Silver Gulls "playing" with Blowfish there and on the same day observed a Silver Gull doing similarly on the South Perth foreshore.

Mr. and Mrs. P. de Rebeira observed a Silver Gull swallow a Blowfish at Pelican Point in December 1967, Mr. David Mell has frequently seen Silver Gulls seize Blowfish discarded by line-fishermen at the Nedlands Baths, Swan River Estuary, and Mr. R. J. McKay has witnessed similar predation.

Mr. McKay also informs me that Silver Gulls have been observed to eat Blowfish at times of the year exclusive of the period October-February and have been seen to disgorge Blowfish during the fish's spawning period (late December to late January).

Between August 1968 and October 1969 I have seen Silver Gulls swallow Blowfish at Mandurah in all months during the

period mentioned and most of the following observations relate to this period.

Some birds, particularly the juveniles, are harried and bullied by other gulls into surrendering their fish and dominant birds, pre-occupied in warning-off nearby gulls, sometimes had their Blowfish stolen from them by other gulls.

Some gulls lost their fish when it sank too deep into the water for it to be recovered and others appeared to just lose interest in the fish. This latter was in some instances probably related to the size of the fish and could also be related to the degree of hunger that the bird felt.

Except for the occasional instances cited, where the gull loses interest in the fish, birds are very reluctant to surrender their fish. Gulls being harried by other gulls usually retain their fish by vigorous evasive action and on one occasion (August 1968) an adult bird would not surrender its fish to a juvenile which mildly begged for it. A gull in shallow water was disturbed by a Pelican, *Pelecanus conspicillatus*, but retained its fish and flew to a nearby weed bank. Several times I have deliberately caused gulls to fly by throwing rocks at them and by suddenly or rapidly approaching them and in most instances they flew away with their fish.

Some food preferences are indicated later in this article but gulls which seized Blowfish during experimental feeding at Mandurah in September 1968 did not abandon their fish when more favoured food was thrown nearby and were not influenced by the mass-hysteria feeding behaviour which built up between gulls and terns when favoured food was freely distributed.

With two exceptions (excluding experimental feeding) all Blowfish which I saw swallowed were not noticeably injured or mutilated externally. The exceptions were a Blowfish which was torn about the abdomen and another which was disfigured generally.

BEHAVIOUR OF GULLS WITH BLOWFISH

Many Blowfish seen in the possession of gulls were deflated and were sometimes quite limp. However, birds were frequently seen with inflated Blowfish and a gull landed near me on the beach of the Mary Street lagoon at Mandurah, with a very inflated Blowfish and a rubbery-squeaking noise was heard as the bird manipulated the fish with its beak.

An immature bird had considerable difficulty with an inflated Blowfish which was floating belly-up in the mouth of the Peel Inlet. The fish looked and behaved just like a table-tennis ball and the gull eventually lost interest in it. An adult gull then swooped down and seized the fish with its feet and flew towards land. Another adult gull was observed to seize another Blowfish, inflated and floating belly-up, in a similar way.

Having obtained a Blowfish, regardless of whether it is inflated or deflated, the gull invariably commences a ritual of kneading and test-swallowing (referred to as "playing" earlier in this article). During kneading, the fish is constantly and strongly manipulated in the bird's beak. The fish is frequently dropped or placed onto the ground but gulls can manipulate the fish with their beaks only. The kneading seems to be mostly directed at the fish's abdomen, i.e., that portion which inflates, and is less frequently directed at the snout and tail. This is usually continued for some 5-10 minutes and the fish are by then noticeably less deflated if not completely so. The gull then usually cautiously tries a test-swallow. That is, it partly swallows the fish, head first, and holds it for a few seconds in this semi-swallowed position.

How far the fish is swallowed varies and seems to depend on the size of the fish and how effective the kneading has been.

It seems that if the bird feels that all is well it then completes the swallowing of the fish but if the fish is still too large, i.e., not deflated enough or perhaps still has inflatory tendencies, it ejects the fish back onto the beach and continues kneading for a while longer. Sometimes this test-swallow and ejection process is repeated several times before the fish is finally eaten. I have never seen a bird leave a fish once it begins this test-swallow behaviour. Once test-swallowing behaviour is begun the bird is apparently convinced that the fish can be swallowed eventually, if not immediately, and perseveres with it. V. N. Serventy (1957) describes an immature gull which left a Blowfish after it had swallowed it and vomited it up again but I would suggest that the observation was the result of other unknown factors.

Birds which obtain Blowfish approximately 12-13 cm. in length seem to have difficulty in swallowing them and the test-swallow process becomes ill defined. The bird simply attempts to stuff into itself as much of the fish as possible by repeated swallowing motions. Ejection of the fish and further kneading usually follows until the fish is finally swallowed.

It was noted that once the fish was swallowed to a position where its tail only just protruded from the bird's mouth (and consequently the bulk of the fish would be well down the bird's gullet) it was almost invariably swallowed without further ado. After swallowing a fish, some birds drank a few mouthfuls of water, and perhaps dabbled a bit, but others showed no interest in water. Fish which were swallowed varied from being clean and water-washed to being covered with fine dry sand or coarse limestone grit.

Birds kneaded and swallowed their fish while standing in a variety of places, i.e., on any part of the beach, on weed banks, grassed lawn, barren sand and limestone rocks and also while floating on water. However, birds definitely prefer to do so on a firm surface rather than on the water. On one occasion a bird which had kneaded and test-swallowed its fish on land was harried by other gulls, lost its fish in shallow water, regained the fish and eventually swallowed the fish while in flight. Birds may seize and carry fish with either the beak or feet.

At Mandurah, in September 1968 a bird was seen walking away from the ocean with a Blowfish held in its beak. The fish was very inflated and was soon dropped on to the damp sand of the beach. The gull then commenced to stamp its feet; a behaviour which has previously been referred to as "puddling" (Wheeler and Watson, 1963). Each stamping bout lasted for some 15-20 seconds and the bird usually moved sideways around the fish, sometimes covering up to 180 degrees of arc. The tail of the fish was occasionally touched by the bird's feet but the two instances when the bird's toes touched the fish's abdomen appeared to be accidental.

It was obviously not behaviour designed to stimulate the fish into further inflation by physical touch, though the bird did lightly peck the fish's abdomen a few times and this would stimulate a healthy Blowfish into inflating itself to maximum size. This stamping behaviour is considered by Wheeler and Watson to be designed to produce food; in their case to bring subterranean food organisms to the surface. This same behaviour has also been seen in captive birds by Mrs. D. and Miss C. A. Nicholls (pers. comm.) who have seen captive birds do it in rainwater pools in the backyard of their Dalkeith residence. A juvenile, which was known to be hungry, also did it while in a cardboard

box. Miss Nicholls has suggested that in the case of the bird with the Blowfish the bird behaved like this in an endeavour to make the food available quickly, i.e., to deflate the fish and bring it to a condition in which it could be safely swallowed, as this can apparently only be done by the time consuming and laborious process of kneading, etc.

Unfortunately the bird left the fish, probably because I approached too closely, and would not return to it. About two minutes after it had been left alone the Blowfish rapidly deflated itself, wriggled violently and flipped over on to its belly. About five minutes later I picked up the fish and placed it in a pool which I scooped out at the ocean's edge. The fish was obviously in a poor condition and could not be induced to inflate itself when I manipulated it by hand. I then placed it in an open slatted box in the water of the Mary Street lagoon but the fish did not respond and several hours later it was dead.

Possessive-aggressive behaviour over Blowfish was seen several times and Wheeler and Watson ascribe this to be general to other fish and food also. The behaviour of a gull with a Blowfish is very distinctive and one can usually judge whether the gull has a Blowfish or some other food.

EXPERIMENTS ON THE BLOWFISH

Blowfish were caught with a fishing line in the mouth of the Peel Inlet, Mandurah, and various experiments were conducted.

When freshly caught the Blowfish is very agile, both in and out of the water. Fish which were hooked and brought close to the surface to permit observation made no attempt to inflate themselves but swam around and would have returned to deeper water if they had not been prevented from doing so. If the fishing line was slackened they invariably dived towards the bottom.

When they were raised from the water and were held dangling on the fishing line they still made no attempt to inflate themselves but wriggled vigorously, trying to free themselves from the hook which held them. However, if they were placed on to a firm surface or were held dangling on the fishing line against a firm object such as a rock or one's leg, they almost immediately inflated themselves. When grasped firmly in the hand, either with or without the hook in their mouths, they invariably inflated themselves to maximum size. It seemed that fish responded more positively and quickly to stimulation of the abdomen than to stimulation of other parts.

When inflated fish, either free or still hooked on the fishing line, were placed or thrown into the estuary or a bucket of water they deflated almost instantaneously and dived for the bottom. A few floated belly up for a few seconds before deflating. This extremely rapid deflation upon coming in contact with the water can be done within a second or two and the fish regain their agility. However one inflated fish which was only held firmly by the tail and which was placed in the estuary did not deflate until I released my grip on its tail. Fish did not deflate if placed or dropped on to the ground unless they were left alone for a few minutes at least.

Inflated fish appear to be able to withstand considerable buffeting without being noticeably injured.

EXPERIMENTAL FEEDING

Experimental feeding was conducted to determine the size of Blowfish which could be swallowed whole by the Silver Gull and to observe behavioural differences in the treatment of fish

such as Yellow-eyed Mullet, *Aldrichetta forsteri* (Valenciennes); Sea Mullet, *Mugil cephalus* Linn; and Perth Herring, *Fluvialosa vlaminghi* Munro, as compared with Blowfish.

Unless otherwise stated the Blowfish were caught with a fishing line. The other fish were caught in set nets in Peel Inlet.

Fishes other than Blowfish. Portions of Yellow-eyed Mullet, Sea Mullet and Perth Herring were eagerly seized and quickly devoured by the gulls. On some occasions Crested Terns, *Sterna bergii*, and Caspian Terns, *Hydropogone caspia*, competed savagely with the gulls, and cormorants and Pelicans tried various harrying methods in endeavours to obtain such food from the gulls. It was noted that under unbiased conditions the Crested Tern was superior to the Silver Gull in obtaining such food.

Strips of fish 7.5 cm. long and 2 cm. square were easily swallowed by Silver Gulls, but with strips of Sea Mullet and Perth Herring, 12.5 cm. long and 2.5 cm. square the gulls usually experienced some difficulty in dealing with them. After swallowing most of such a strip the gull usually dabbled the rest in water while completing the swallowing of it and frequently drank water immediately afterwards. The strips of fish were frequently manipulated for a minute or two before the birds attempted to swallow them. One bird nearly completely swallowed a strip this size then walked and flew around for a few minutes with the strip of fish held in the same position. It then ejected the strip of fish on to the beach and manipulated it for a while before swallowing it completely.

Birds were seen devouring these strips of fish by repeated swallowing motions identical to the manner in which the larger Blowfish are swallowed (see section, Behaviour of Gulls with Blowfish).

Blowfish. In August 1968 I found a dead Blowfish, approximately 8 cm. long, on the damp sand of Halls Head Beach, Mandurah. The fish was moist and had dry sand adhering to it. I threw it up into the air so that it would be visible to a group of Crested Terns and a Silver Gull. The gull detached itself from the terns and landed near where the Blowfish had fallen. The bird would not touch the fish but may have been wary of my presence. I walked further away and a second gull swooped down, seized the fish and flew some distance away. It commenced to knead the fish and after a few minutes tried a test-swallow. It ejected the fish, kneaded it for a few more minutes and then swallowed it.

In September 1968 a gull was seen with a Blowfish on the Hall's Head Beach. The bird manipulated the fish for about five minutes and then lost interest in it. A second gull seized the fish but after kneading it for a few minutes it also left it. A third gull commenced to knead the fish but did not seem very interested in it so I flushed the bird and retrieved the fish. The Blowfish was dead and the only obvious disfigurement was the absence of some of the pigment on the head and back, these areas showing the "naked" whitish coloration underneath. I judged that disfiguration was caused by the birds' beaks. (The dark pigment of the Blowfish can be removed by firm scraping with a sharp knife). The fish was 12.6 cm. long and when placed belly down on a table had a girth of 8.2 cm. behind the fins. Displacement of the fish's abdomen towards the head gave a maximum girth of 8.8 cm. and displacement towards the tail gave a maximum girth of 8.2 cm.

Next day this fish, together with portions of Yellow-eyed Mullet, Sea Mullet and Perth Herring, was thrown to a group of

gulls and terns at the Mary Street lagoon. A Silver Gull seized the Blowfish landed on the water of the lagoon and commenced to knead it. After about a minute it lost interest in the fish however and allowed it to sink. Another gull then dived into the water, seized the Blowfish and flew around with it for a short while before settling on to the water of the lagoon. It manipulated the fish for a few minutes and then partly swallowed it until only about 2 cm. of the fish was visible between the bird's beak. The bird did not have any apparent difficulty in swallowing the fish this far. However it was then flushed from the water by other gulls, evaded them and with the fish in the same position flew around for a while before settling on a rock. The Blowfish was then swallowed completely.

At the same period, September 1968, I fed many Blowfish to the gulls. Some fish were still alive but others I killed before offering them as food. There was no obvious difference between the treatment given to a live Blowfish and a dead one.

The largest two of these fish that were swallowed were 12 cm. and 13.2 cm. in length, respectively. Larger Blowfish, approximately 15 cm. in length, were seized by gulls but were usually discarded again after only a small amount of manipulation and spasmodic pecking. Some of these larger fish were retrieved and cut into portions or halves. Birds readily seized these pieces and the entrails were eagerly devoured. Birds which seized the head half of such fish seemed to spend more time kneading and had greater difficulty in swallowing than did birds which seized the tail halves.

Even with these halves the same ritual of test-swallowing and ejection was adopted by the gulls. In some instances, particularly with the entrails, small portions of Blowfish were swallowed instantly, but generally the small portions were treated with a caution which is non-existent when birds seize a similar-sized piece of other fish, such as Perth Herring or Yellow-eyed Mullet.

A Sea Mullet, a Perth Herring and a Blowfish 12 cm. long, were threaded through their heads with a piece of twine which was fixed to barren sand approximately 75 yards from the Mary Street lagoon. Each fish was cut down its abdomen so its entrails were exposed and part of the skin of each fish was peeled back to expose the flesh. Gulls readily ate the entrails of all three fish. Examination of the fish a few hours later revealed that only the head of the Perth Herring remained, the Sea Mullet had been slightly eaten and the Blowfish remained whole except for its entrails. Another examination several hours later, at dusk, revealed that the Perth Herring was gone, only the head and part of the skeleton of the Sea Mullet remained and the Blowfish was untouched as before. The only two birds which may have biased this experiment were two Ravens, *Corvus coronoides*, which were seen to eat portions of the Perth Herring and Sea Mullet.

Next day a Sea Mullet, a Yellow-eyed Mullet, a Perth Herring, the Blowfish from the previous day's experiment and a freshly caught Blowfish, 11-12 cm. long, were staked down to the beach of the Mary Street lagoon as before. The new fish were prepared similarly, and the Blowfish from the previous experiment was washed and cleaned of sand.

Again the gulls readily ate the entrails of all the fish and again exhibited a preference for the flesh of fish other than the Blowfish, though they often pecked intermittently at all fish. Approximately 6 hours later the Perth Herring was gone, the Yellow-eyed Mullet was eaten except for the head and portion of the skeleton, the Sea Mullet was mostly eaten, the Blowfish

of the day before was partly eaten but the fresh Blowfish was whole except for its entrails of which only a small portion of intestine remained.

This experiment was biased as the two Ravens were observed feeding on the flesh of various fish, except the Blowfish, and also ate some of the Blowfish's entrails. A Pelican tried to wrest the Sea Mullet from the twine and both a Pied and a Black Cormorant, *Phalacrocorax varius* and *P. carbo*, also tried to wrest the Sea Mullet and the Yellow-eyed Mullet from the twine. All were unsuccessful but as the fish were not under observation for several hours it is probable that more extensive predation took place.

In October 1968, a Blowfish approximately 13 cm. long, which was found dead on the beach, was placed on the edge of the Mary Street lagoon together with battered portions and halves of Blue Manna Crab, *Portunus pelagicus*. A dominant Silver Gull took possession of the area and ate the flesh of the crabs, but spent most of its time trying to discourage other gulls from obtaining this food. While this dominant bird was engaged in such possessive-aggressive behaviour other gulls frequently succeeded in obtaining some of the crab flesh. Many of these gulls, especially those with dark beaks and drab coloured legs, often directed their initial attention to the Blowfish. Apparently they visually recognised the Blowfish as food rather than the pieces of crabs, but felt that the Blowfish was not the objective and subsequently diverted their attention to the crab pieces and "discovered" the flesh.

SOURCES OF THE BLOWFISH

Because this Blowfish is a bottom-dwelling species it would not frequently be preyed upon directly by the Silver Gull. It becomes available to the gull, however, both naturally and as offal deposited on the beaches by fishermen.

An instance of direct predation came under my notice at Mandurah in a mid-afternoon in January 1969. I counted 48 Silver Gulls manipulating small Blowfish about 5 cm. in length and in various stages of inflation, on the beach of the bay between the Peninsula Hotel and the Mandurah Road. Several other gulls with Blowfish were floating on the water. These were catching the Blowfish either by "duck-diving" while floating in the water or by shallow diving from a hovering position. "The duck-diving" method is also used by the Silver Gull to obtain other food from the shallow waters of the Mandurah estuary. About 15 minutes later most of the fishing activity had ceased and only five birds with Blowfish were counted. Many of the gulls present in the area were quietly standing on the beach but an aggregation of about 150 birds was floating in an area of some quarter of an acre, obviously searching and waiting for more Blowfish to appear. A short while later the gulls were seen to be catching Blowfish again, and it was noted that most birds flew to the beach to manipulate their fish, only a few remaining to do this in the water. The majority of the Blowfish had inflated themselves by the time the birds had flown to the beach, a distance of some 50-75 yards. During the following half-hour birds were intermittently obtaining and swallowing Blowfish. Two approximate counts of gulls with Blowfish on the beach gave numbers of 25-30 birds on each occasion. During the whole period of observation over 100 Blowfish must have been caught and eaten by the gulls.

Blowfish are often found cast up on oceanic beaches, particularly after heavy seas and this source must provide a reasonable supply to the gulls. However not all of these are eaten by them as mummified and decomposing bodies are frequent.

It is also possible that predatory fauna, such as cormorants, may contribute to natural casualties by catching Blowfish and then discarding them.

One of the greatest sources of Blowfish now available to gulls must be that provided by amateur line fishermen, who catch and discard considerable numbers, usually disabling them unless they are thrown away in a situation where they cannot re-enter the water.

Professional fishermen catch Blowfish in their nets, too, and the few I have seen caught by these means, at Mandurah, were either near dead or left in the net until dead before being discarded.

Blowfish sometimes float, inflated and upside down, and in the Mandurah estuary this appears to be seasonal, i.e. at the beginning and after the winter rains, when the salinity alters.

It is significant, perhaps, that nearly all of my Mandurah observations on Silver Gulls with Blowfish took place downstream from the traffic bridge and on the adjacent ocean beaches. This could be correlated with fishing activities upstream. Searches for Blowfish on the ocean beaches north to Madora and south to Miami at the same time yielded negative observations.

OTHER PREDATORS OF THE BLOWFISH

V. N. Serventy (1958) recorded the Seastar, *Patieriella gunni*, preying on this Blowfish at Trigg's Island in March 1958.

Mandurah fishermen, L. and A. Renfrey, both inform me that large Tailer, *Pomatomus saltator*, "5 to 8 lb. in weight" frequently have halves and portions of this Blowfish in their stomachs.

Salmon, *Arripis trutta*; Snapper, *Chrysophrys unicolor*, and some species of tuna have also been recorded preying on this Blowfish (R. J. McKay, pers. comm.).

Miss C. A. Nicholls found approximately 10 undigested Blowfish of this species, approximately 5 cm. long, in the stomach of a Yellow-nosed Albatross, *Diomedea chlororhynchos*.

S. A. White (1916) found "toadfish" (sp?) in 2 of 35 Pied Cormorants, *Phalacrocorax varius*, collected at a rookery in the mangrove creeks north of Port Adelaide, South Australia, in March 1916. One bird had one toadfish in its stomach and the other 27. White commented that nature must have provided the birds with immunity against the fish's poison. McKeown (1944) found three "Toado" in one of four Pied Cormorant stomachs.

NON-PREDATORS

Pelicans were incited by the behaviour of gulls and terns into approaching whole or portions of Blowfish but they invariably lost interest in the fish after visual recognition. This contrasted with their eagerness to seize pieces of Yellow-eyed Mullet and Perth Herring and their attempts to harry gulls and terns into releasing such fish.

Caspian Terns often swooped at Blowfish thrown onto the beach or into the water but never seized them or took further interest in them after visual recognition.

Crested Terns frequently seized Blowfish with their claws but only carried them for short periods. The longest time I saw a bird of this species hold onto a Blowfish was for approximately 20 seconds. Usually the birds released the Blowfish within five seconds or so. Sometimes when a Crested Tern released its fish a second tern immediately seized it, the second bird apparently

thinking that the first bird had accidentally dropped the fish. The second bird invariably realised its error and released the Blowfish too and on a few occasions a third and even a fourth bird followed suit. The readiness with which Crested Terns discard Blowfish contrasts markedly with their usual behaviour after they have seized favoured fish. The terns usually promptly swallow such fish in flight, and frequently seize them with their beaks. It was noted however that Blowfish were always seized with the feet. Sometimes individuals release a Blowfish and then catch it again before it hits the water.

I was unable to induce either the Pied Cormorant, *Phalacrocorax varius*, or the Black Cormorant, *P. carbo*, to take Blowfish and their behaviour was identical to that of the Pelicans. However, in view of White (1916) and McKeown (1944) the negative results in this instance were probably conditional.

BIOLOGY OF THE BLOWFISH

Life history: Mr. R. J. McKay has given me the following note: "*Spheroides pleurogramma* can attain maturity when 7.4 cm. in length at an age of possibly 2 plus years. It attains a maximum size of 15.2 cm. (= 6 in.).

"The gonads ripen during late-October to mid-January and the species commences spawning between late-December to late-January.

"Its poisonous properties are at a maximum from late October to late January/early February. Other species of blowfish are poisonous throughout the year and it would be safe to assume that *S. pleurogramma* is too. This species is responsible for all the human fatalities which have occurred in local areas, and dogs and cats are frequently stricken by blowfish poisoning during the summer months."

The nature of the poison: The poison secreted by the Tetraodontidae has been named Tetraodontoxin, and the chemical composition of that in a Japanese species, *Fugu rubripes*, has been published in 1952 by Yokoo (cited by Whitley, 1953).

Dr. B. W. Halstead, Director of the World Life Research Institute, Colton, California, an authority on fish poisons, has informed me that chemical isolation studies have shown that in some species the poison registers at about 0.08 mg. per kg., which represents a lethality of about 10,000 times that of sodium cyanide. Less than 1/400 oz. can be fatal to a human being. Some species of animals are severely and fatally affected by Tetraodontoxin but others are immune to it. Such poisoning or immunity can be independent of the season or the state of maturity of the fish (Whitley, 1953). Many instances are cited of severe and fatal poisoning in human beings, rats, cats, pigs and fowls, resulting from blowfish being eaten. Some organisms are immune to the poison, or relatively so, when it is taken orally, but are killed rapidly when it is injected.

Dr. Halstead also informs me that in birds which are not affected by the poison it could be that the bird is not susceptible to it, or that it selectively absorbs it, or that there may be an intestinal barrier of some type. Studies conducted to date show that there are many reasons and that they have to be very carefully evaluated.

FAUNA UNAFFECTED BY EATING BLOWFISH

The animals cited previously in this article as being affected or non-affected by the poisonous properties of the Tetraodontidae can be divided into two groups:

(a) Terrestrial species, ie. fowl, rat, cat, dog, pig and man, which are severely and fatally affected. An exception is the Raven, which only ate the entrails during my experimental feeding tests.

(b) Marine species or species inhabiting marine environments, ie. seastar, tailer, salmon, snapper, tuna, albatross, cormorant and gull which appear to be immune to the poison.

Dr. D. L. Serventy, CSIRO Division of Wildlife Research, has pointed out to me that group (a) consists of recently introduced exotic species while those in group (b) have had a long ecological association with the Tetraodontidae and may have evolved immunity to their toxins. However Dr. Halstead (pers. comm.) has found that endemic temperate zone fish which have never had contact with tetraodontid poisons are also immune to them. Consequently a full explanation remains of this interesting situation.

SUMMARY

Spheroides pleurogramma is a common Western Australian species of the poisonous blowfish family, Tetraodontidae, but field observations and feeding tests indicate that the Silver Gull, *Larus novae-hollandiae*, is normally unaffected by the poison. The inflammatory mechanism of the Blowfish is dangerous to this gull which methodically kneads the fish so that it can be safely swallowed. Blowfish up to 13.2 cm. in length can be swallowed whole, and portions and entrails of larger fish up to 15 cm. are also eaten. Both adult and juvenile gulls eat Blowfish, though other fish species are preferred if a choice is available.

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