Flatworm predation of terrestrial molluscs in New Zealand, and a brief review of previous records

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ABSTRACT

The terrestrial flatworm *Geoplana ventrilineata* Dendy is recorded as a predator of introduced and endemic slugs in New Zealand. Previous records of flatworms predating on land snails and slugs are briefly reviewed.

Keywords: Turbellarian flatworm, *Geoplana ventrilineata*, predation, mollusca, slugs, snails, New Zealand.

The tubellarian flatworm fauna of New Zealand is still poorly known, despite early accounts by Hutton (1880), Dendy (1895, 1896, 1897, 1901), Graff (1899), Steel (1901) and Fyfe (1944, 1946, 1947, 1956). There are no keys available for their ready identification and their biology is scarcely known. There are at least 7 species of terrestrial flatworms introduced into New Zealand, excluding the cosmopolitan *Bipalium kewense* Mosely (Winsor pers. comm.).

Introduced slugs (Gastropoda, Stylommatophora) form an important but poorly understood component of modified habitats in New Zealand.

Knowledge of taxonomy, biology and distribution of these slugs in New Zealand was revised by Barker (1979). Because of their pest status, there has been a renewed interest in the biology of slugs.

On a number of occasions during the autumn of 1980, a terrestrial turbellarian flatworm, *Geoplana ventrolineata* Dendy, was seen to predate on slugs in a Hamilton garden. The flatworm and a number of introduced molluscs were abundant by day under wooden seedling trays in a damp shaded site. At night the flatworms were seen actively seeking prey. They moved with surprising agility and speed. Their anterior end was attenuated, often elevated and flailed about in an apparent attempt to locate prey. Isopods, the most common prey, were taken by individual flatworms, but slugs (*Deroceras panormitanum* (Lessona & Pollonera)) were attacked in mass by a number of flatworms. Flatworms appeared sensitive to nearby *Deroceras* and frequently made a direct approach and attack on the slug. The initial attack was usually followed by a mass attack by further flatworms. As many as 7 flatworms were observed on 1 adult *Decroceras*. The flatworms inflicted wounds to the slug body surface by their extended probosci. The slug was usually killed, often within an hour. The mucus discharge by the slug did not discourage the flatworms. Other species of molluscs in the garden were not observed to be attacked by the flatworms.

On a further occasion a flatworm was observed feeding on a live juvenile specimen of the endemic slug *Athoracophorus bitentaculatus* (Quay & Gaimard) in bush litter at Waitomo. The flatworm, identified as *G. ventrolineata,* had coiled about the slug and made repeated probings with its proboscis, removing small pieces of tissue. The slug was dead after 10 minutes.

Froehlich (1955) described feeding of 6 Brazilian *Geoplana* species on a number of snails and Limacid slugs: "When a snail-eating land planarian touches the body or the shell of a snail, it adheres with the anterior end to the prey. It then creeps over and around the shell, usually surrounding the shell completely. The pharynx now gets into position at the opening of the shell (the snail, if not already within, always retreats into it when attacked) and begins to suck the snail. When hungry, the land planarian generally cleans up neatly the shell; when well fed, it may leave half-digested remains. Some snails, when attacked, produce masses of froth, succeeding often, in this way, to ward off the land planarian . . . When a slug-preying land planarian touches the body of a slug with its anterior end, it adheres to the prey and extends the body forwards, trying to get hold of the head of the slug, preventing the slug's escape. The slug on the other hand, secretes on the whole surface a fluid mucus to counteract the adhesive glands of the planarian, and also begins to creep at full speed. Sometimes it manages to escape, but often the planarian succeeds in encircling its head and cutting off the retreat. The land planarian then creeps over the slug, keeping the body broadened and the margins closely adhered to the substrate in the region where the slug is. When the slug is within reach of the pharynx, this is protruded, and the slug is swallowed . . ."

Gislen (1944) and Jennings (1959) list snails (*Oxychilus cellarius* (Muller), *Cepaea nemoralis* (L.)) and slugs (*D. agreste* (L.)), *Arion hortensis* Ferussac) as common food items of European *Microplana terrestris* (Muller). The attack on arionid slugs is described by Jennings (op. cit): "When an appropriately sized slug . . . is encountered the flatworm rapidly extends across the width of the prey until it can grip the substratum on each side and so pin the captured animal beneath the arched body. The grip on both prey and substratum is helped by copious secretions of mucus from the ventral surface and is so effective that prey rarely escape. Movement across the prey continues until the mouth . . . can be brought into contact with it. The muscular tubular pharynx is then protruded through the mouth and . . . thrust through the body wall . . . Once within the body cavity the pharynx moves around disorganising the softer tissues to pass them back in a finely divided condition into the gut. The disruption of the tissues is rapid, and, like the penetration of the body wall, is mechanical with the pharynx acting as a simple suctorial tube extracting tissue fragments and body fluids. Withdrawal of the body contents continues until either only the collapsed and empty body wall is left, or the flatworm is replete . . ."

Klots (1960) reported that *B. adventitium* Hyman feed on slugs in north eastern United States.

At the Agricultural Research Station in Manokwari, West New Guinea, Schreurs (1963) found the relatively large rhynchodemid flatworm *Platydemus manokwari* de Beauchamp to be an endemic predator of slugs. Driest (1968) of that station observed these flatworms attacking both slugs and *Achatina fulica* Bowdich, the giant African snail. In a number

of cases, slugs that had been attacked developed "characteristic blisters" on the dorsal surface and died. Experiments with *A. fulica* were somewhat inconclusive, but Schreurs (1963) announced ". . . it is very possible that the complete disappearance of the African snail as a pest in some parts of Manokwari has been the result of the activities of the flatworms, as they were present in these localities. The flatworms were also seen in large numbers, almost without exception, in the fenced-in fields where predatory snails were released. They were often seen on and inside the shell of the dead predatory snails. Very likely the high mortality of the predacious snails in the field was caused mainly by these flatworms, as in the cage the snails were successfully kept alive."

In the late 1970s and early 1980s *P. manokwari* was accidentally introduced to Guam and the northern Mariana Islands respectively, which resulted in the effective control of *A. fulica* (Muniappan 1983; Muniappan *et al.* 1986). Subsequently, deliberate introduction of *P. manokwari* into *A. fulica* infested atolls of the Maldives resulted in control of the snail populations there (Muniappan 1987).

Mead (1963, 1979) describes intensive predation of *A. fulica* and other terrestrial molluscs in Hawaii by *G. septemlineata* Hyman. In a graphic account Mead (1963) describes mass attack on even the largest snails ". . . they seem sensitive to slime trail of a snail; and, in the vicinity of these worms, a snail is soon seen with a number of worms crawling almost frantically in its wake. The directive motion of the worms permits them soon to overtake the snail with its hesitant, probing locomotion. One after another crawls upon the hapless victim until it is apparent that one of the most effective factors in the attack is the 'ganging up' of the worms on a snail whose escape reaction succeeds only in carrying its attackers with it and picking up still more en route . . . the prey is unduly sensitive to physical contact with these worms, since it elaborates a considerable amount of heavy, greenish, forthy mucus. This discharge does not discourage the worms . . . The sensitivity of the snail grows more acute with more worms moving into position; and the victim withdraws into its shell dragging the worms in with it and embracing them in the folds of the invaginated head and tentacles . . . The harassed snail opens the pneumostone in a desparate effort to get more air; and some of the worms crawl into the lung cavity. Soon the irritation and congestion in the lung, as evidenced by the copious amount of mucus produced in the lung and the bubbling from the pneumostrome, causes the pneumostone to remain open, only to permit still more worms to enter until a veritable webbing of black worms can be seen." The intense suction of the worm's proboscis removes flesh from the exposed parts of the snail and the invasion of the lung cavity subjects the vital pallial organs to attack.

The newly hatched achatinas are most preferred by *G. septemlineata* and the destruction of juvenile snails is thought to be the principal means of *A. fulica* biological control in Hawaii (Mead 1963). The flatworms congregate in great numbers in the egg masses. In attacking the newly hatched snail, the worm either embraces it in its folds so that the proboscis can enter the aperture of the shell, or it crawls into the shell and out again, forming a U-shaped fold that carried the proboscis deeply into the body whorl. The small shell characteristically is left intact and completely clean of any flesh.

Geoplana septemlineata in its unaltered Hawaiian endemic state is apparently not a common animal. It has been seen feeding on earthworms and small insects. Snails originally may not have figured importantly in its diet as approximately half of the Hawaiian endemic snails are tree dwellers. With the arrival of *A. fulica*, and then the introduction of the predatory snails *Gonaxis quadrilateralis* (Preston), *G. kibweziensis* (Smith) and *Euglandina rosea* (Ferussac), an abundant supply of acceptable food became available. The population of *Geoplana* unquestionably increased considerably as a result (Mead 1963).

Ash (1976) observed *Geoplana forsterorum* Schroder to feed on the tissues of dead and dying snails and slugs in New Caledonian gardens.

Smith (1979) received a report of 7 flatworms attacking and eating a *Helix aspersa* Muller in a Victoria garden. Both *Geoplana atrata* Steel and *G. ventrolineata* were involved. Smith considered it doubtful that flatworms would attack live molluscs, but acknowledged their feeding on dead animal tissue. He recalled seeing *G. atrata* feeding on a dead *Bulinus* snail.

The geoplanids and their allies are widespread and it is probable that in many places

their presence has an effect upon land mollusc distribution and abundance. *Geoplana ventrolineata* is common in modified habitats in both eastern Australia and New Zealand and represents at least 1 case of predation on molluscs among the New Zealand flatworm fauna.

ACKNOWLEDGEMENTS

Dr D. I. Gibson (British Museum Natural History) and Dr L. Winsor (James Cook University, Queensland) for identification of flatworms.

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