Colonisation of New Zealand by *Hemicordulia australiae*, with Notes on its Displacement of the Indigenous *Procordulia grayi* (Odonata: Corduliidae)[1]

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Summary

From records reviewed in this paper it is inferred that the first resident populations of *Hemicordulia australiae* in New Zealand became established in the early 1930s on the Rotorua-Taupo Volcanic Plateau and/or in the Auckland area, that this species colonised New Zealand by aerial dispersal, and that by 1960 it had colonised the North Island and invaded the South Island. On Lake Taupo, *H. australiae* has displaced the indigenous *Procordulia grayi;* it remains to be seen whether it will do so elsewhere.

INTRODUCTION

The first reference to *Hemicordulia australiae* (Rambur) being found in New Zealand was made by Jules Pierre Rambur, the original describer, who in 1842 (p. 146) named it as an Australian species, but stated that he had a New Zealand example. The subsequent collectors Hutton (1899) and Hudson (1904) omitted this species when listing the New Zealand corduliines, but it was included by Tillyard (1926, p. 85) who stated: "*H. australiae* . . . ranges far and wide over Australia, Tasmania, Norfolk, Lord Howe, and Kermadec Islands, and is occasionally taken in New Zealand." It appears that, at least until the time of Tillyard's account, *H. australiae* was only a rare visitor to New Zealand. Hudson (1950, p. 122) writes of this species: ". . . I have only a single specimen, taken at Lake Horowhenua on February 17th, 1901 . . ."

COLONISATION

Arrival and colonisation on the Rotorua–Taupo Volcanic Plateau

I had collected in the Taupo District from 1926 until 1931 without seeing *H. australiae,* which is easily distinguished in flight (Armstrong 1957) from the two other corduliines found there: *Procordulia grayi* (Selys) and *P. smithii* (White). This is consistent with the fact that Hudson, who collected around the district on several occasions before 1930, never caught a specimen, and that Tillyard (1920) does not mention this species in his report on neuropteroid insects of the Hot Springs Region, although he does mention both *P. grayi* and *P. smithii.* No record is known of *H. australiae* having been seen or caught over this Plateau until 19 February 1931 when I saw two individuals flying over the Waikato River near the bank, a little below the point where the stream that flows through the Spa Hotel grounds enters the river; one of these, a male, was caught and identified.

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[1] This paper is based on an unpublished report presented at the Annual Meeting of the Entomological Society of New Zealand in 1963.

[2] Dr J. S. Armstrong died on 7 February 1977, and I have assumed responsibility for submitting this paper for publication. The text was approved by Dr Armstrong on 26 January 1977. Correspondence regarding this paper may be directed to me: PHILIP CORBET, S. A. 1959: The larval development and emergence of *Aeshna cyanea* (Müll.)

On 23 January 1934 I first encountered a colony of adult *H. australiae* in a dry gully leading down to the stream running through the Spa Hotel grounds. (The larvae had presumably developed in the pools of the stream.) On this date more than a dozen adults, including both males and females, were hawking for flies up and down the gully, and resting occasionally on the tips of the branches of the pine trees that bordered both sides of the gully, usually choosing sites exposed to the sun. This colony persisted for several years and may have been one of the foci from which the species spread over the Volcanic Plateau. However, in 1946 a bad fire burnt the pine trees; this probably made the gully unfavourable as a hawking site and thus led to the dispersal or destruction of the colony.

In May 1935 I sent specimens from this colony to Dr David Miller to confirm my identification, and he responded thus: "As you suggest, the dragonfly is *Hemicordulia australiae*, and the fact that it is found in large numbers in Taupo each year is of very great interest since heretofore we have records of its occasional occurrence in New Zealand only."

I saw adults showing reproductive activity at Richard's Pool, Waikato River (first sighting in 1936), Acacia Bay[1] on Lake Taupo (first sighting in 1945), and I saw a few adults at many other places around the lake and as far away as Lake Rotorua and the Whirinaki River near Te Whaiti.

Because I was away from New Zealand for most of the time between 1950 and 1956 I have no notes for this period, but on returning I was able to tour the district. I found colonies well established at the old sites on Lake Taupo and found several in new sites in Western Bay, Waihi, Turangi, Hatepe, and Waitahanui. Other lakes now known to contain resident populations include: Roto Aira, Orakei Korako, Green Lake near Rainbow Mountain, Okaro, Tarawera, Rotorua, Rotoiti, and Rotoma. A systematic search in the Volcanic Plateau District would probably show resident populations to exist in all the lakes and in most of the streams and rivers that feature suitable pools.

Colonisation elsewhere

When Dr M. A. Lieftinck visited New Zealand in January and February 1949, he reported (1953, p. 185) that *H. australiae* was extremely common at Lake Pupuke, swarming and breeding there in very great numbers. He suggested that this situation was the result of Lake Pupuke being a man-made habitat, not yet occupied by other species, but nevertheless suitable for larvae of *H. australiae*, which at the time was one of the commonest dragonflies in the lowlands around and north of Auckland. On three visits to the North Auckland area in 1959, 1961, and 1962 I found *H. australiae* to be common and almost certainly resident in the following places: lakes behind Bethell's Beach, Lake Pupuke, Kaiiwi Lakes (on the west coast north of Dargaville), the stream near Trounson Kauri Park, Waipoua Kauri Forest (on State Highway 12 about 58 km northwest of Dargaville), Lake Ngato (probably one of the Sweet Water Lakes) near Kaitaia, Lake Ohia (north of State Highway 10 where it crosses the base of Cape Karikari Peninsula), Puketotara Stream near Puketi Forest, and Kamo near Whangarei. From its wide distribution in the North Auckland area we may infer that *H. australiae* has been there as long as, if not longer than, on the Volcanic Plateau.

Localities south of Taupo have not been examined as thoroughly as have those to the north, but I visited Lake Horowhenua on 23 October 1958 and

[1] Where possible, names of localities conform to those listed in the most recent gazeteer (Anon. 1968).

found several *H. australiae,* including both sexes, flying between the lake and the shelter-belt of pine trees south of the lake. This shelter-belt must have been planted after Hudson's visit in 1901 and will have made the lake more suitable for breeding, which appeared to be vigorous (to judge from the large numbers of adults seen early in the flight season). I visited Gollans Stream on 7 February and 6 December 1958: on both occasions *H. australiae* was the commonest dragonfly seen and more numerous than all the other corduliines considered together. It appears that the larvae there occupy deep pools in the main stream.

When visiting the South Island in 1958 I saw several *H. australiae* flying over the old camp site and the camp reservoir at Farewell Cape, but the sudden advent of successive cold spells gave me little opportunity of seeing dragonflies on the wing during the rest of my tour, and I saw no more *H. australiae.* On 17 December 1962 Mr J. G. Penniket saw several corduliines flying over a stream near Dobson on the west coast and caught one: a female *H. australiae.* From these few observations it seems likely that lakes and rivers on the west coast have been colonised. I have no knowledge of the status of *H. australiae* east of the main ranges.

It may be assumed that *H. australiae* reached the South Island by aerial dispersal and not as the result of introduction by man: the larvae sent by A. L. Tonnoir from Tasmania in the 1930s and liberated at Cass, at Christchurch, and at Nelson in the Maitai River (in an attempt to control simuliid larvae) were *Austroaeshna* sp. and not *H. australiae* (see Anon. 1931; Miller 1969).

Effect on indigenous dragonflies

Writing of the reduction of dragonfly larvae in the Hot Springs Region, Tillyard (1920, p. 209) remarked: "It seems clear that their numbers have been much decreased since the trout were freed in these lakes and rivers . . ." In the past I have seldom found more than six Anisoptera larvae per trout stomach, but recently I have counted up to 30 final-instar larvae of *H. australiae* per stomach in two trout living in lakes formed by hydroelectric developments in the Waikato River, particularly at Aratiatia. Tillyard's statement included *Procordulia grayi,* which he mentioned specifically. However, my observations from 1931 until 1949 showed that *P. grayi* larvae remained very common along the rocky shores of Lake Taupo and still more so on Lake Roto Aira, where fishermen considered this species to be one of the main food items for trout. My notes for this period show that the rocks partly submerged in the lake water on the northwestern side of Taupo Bay in late January or in February carried hundreds, and probably thousands, of *P. grayi* exuviae each year.

When emerging, both *P. grayi* and *H. australiae* leave their exuviae on an object, such as a rush stem or a stone, that has its lower part beneath the water. This conveniently limits the area along the shore which can harbour exuviae, and accordingly means that counts of exuviae provide an easy, accurate measure of the relative numbers of each species emerging from such a site.

My notes record that on one day in 1949 I removed 32 exuviae of *P. grayi* from a single rock on the north side of Acacia Bay. Trout were rising to the females ovipositing on the water surface of the bay, but no female was seen to be caught. There were many exuviae of *P. grayi* also on suitable rocks nearby; however, no exuviae of *H. australiae* were found on the rocks, and only a few on rushes at the southwestern corner of the bay.

On the same rocks in February 1962 there were 51 exuviae of *H. australiae* and none of *P. grayi*; in Acacia Bay and the neighbouring bay more than 100 exuviae were collected, and only one amongst them was of *P. grayi;* at least another 60 exuviae were seen and recognised as belonging to *H. australiae*. Dozens of *H. australiae* were seen flying over the lake, but not one *P. grayi*.

From these condensed notes it seems that at Lake Taupo *P. grayi* has been supplanted by *H. australiae,* though how this has come about is not clear. On the other hand, in Lake Roto Aira, it appears that *P. grayi* is competing successfully with *H. australiae;* although both species have inhabited the Lake for several years, *P. grayi* is still the commoner of the two. Larvae of both species were present in the stomachs of trout caught in the lake on 26 June 1962, and forwarded to me by Major Frank Yerex. At times, however, larvae of *H. australiae* can form up to half the stomach contents of trout in this lake.

I conclude by mentioning two factors which may have influenced the displacement of *P. grayi* by *H. australiae* in Lake Taupo.

First, close settlement of the shore (with associated pollution of shallow water) and local road construction (with consequent disturbance of the shore) would have caused pumice to settle on the lake bottom and would thus have changed the aquatic vegetation. This effect is most evident in the spread of plants such as *Elodea,* which form a dense mat on large areas of the lake bed and so displace open vegetation such as *Ranunculus aquatilis, Potamogeton natans, P. crispus, Chara,* etc., which were previously common alongside the rocky area where *P. grayi* larvae lived and emerged. Dredging has shown that late-instar larvae of *H. australiae,* but not of *P. grayi,* live in the *Elodea* mat.

Second, a higher water temperature at the breeding site can be expected to favour *H. australiae*. It appears that *P. grayi* competes more successfully in colder habitats, for example the lakes and mountain streams of Tongariro National Park.

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