STUDIES ON THE LARVA OF *ONISCIGASTER WAKEFIELDI* (EPHEMEROPTERA: SIPHLONURIDAE) IN WAITAKERE STREAM, AUCKLAND

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SUMMARY

The larva of the primitive mayfly *Oniscigaster wakefieldi*, McLachlan 1873 (Ephemeroptera: Siphlonuridae) was studied in the Waitakere Stream, near Auckland, New Zealand, over a 17-month period extending from July 1965–November 1966. A wide-mouthed dragnet enabled monthly samples (average 46 specimens) to be collected for detailed studies of the larval growth pattern; this collecting method revealed that the species, previously thought to be rare, is numerous both in the study area and elsewhere in North Island, New Zealand.

O. wakefieldi has a univoltine life cycle with 20–25 larval instars. The larvae prefer different habitats according to their age and can be divided into three distinct groups: larvae 1–10 mm in length are found on finer sediments in quiet shallow water; 11–18 mm in length inhabit waters up to 50 cm deep where the substratum is mainly of pebbles (0.4–4.0 cm diameter) set in a silt matrix; and mature larvae 19–26 mm in length are found adjacent to dry emergent boulders, often at the base of riffles.

Three larval characters are described for the first time to separate the larvae of *O. wakefieldi* and *O. distans*. Sexual dimorphism is evident in *O. wakefieldi* populations by size difference; in the last larval instar, females average 4 mm longer than males. The known distribution of the species in North Island is illustrated.

INTRODUCTION

Few New Zealand mayflies have promoted as much interest as *Oniscigaster wakefieldi* McLachlan 1873 because it is considered one of the most archaic members of the paleantarctic fauna (Edmunds 1957) and was once thought to be extinct. In 1959 J. G. Penniket rediscovered it on the West Coast of the South Island (Penniket 1962); he recorded details of the larval habitat, the habits of the larva and subimago, and the emergence of the subimago.

This study adds more information on the life history and larval ecology of a population in the Waitakere Stream, Auckland.

STUDY AREA

The Waitakere Stream flows through Cascade Kauri Park Reserve, 18 miles west of Auckland (Fig. 1). The section of the stream studied (Fig. 2) lies below the Waitakere Dam at a mean altitude of 63 metres;

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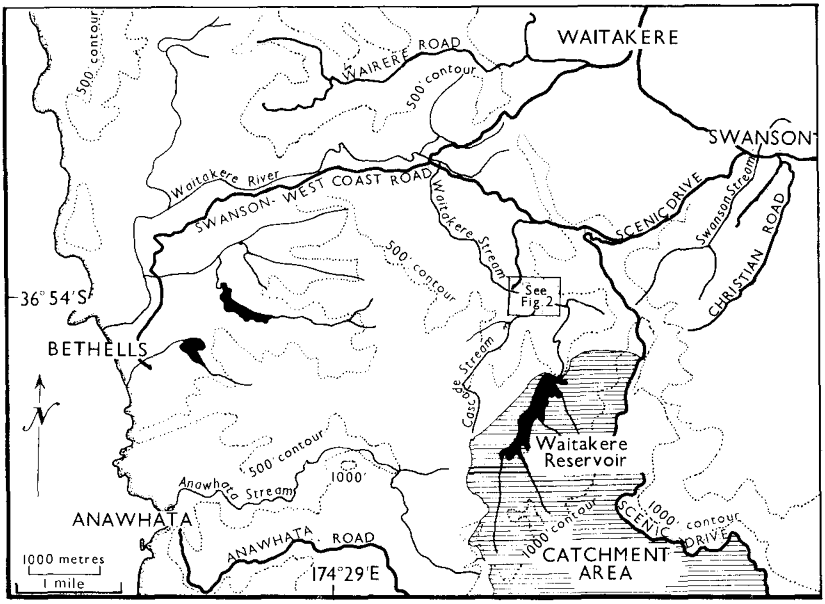

FIG. 1—Location of study area (inset) on Waitakere Stream and relief of environs.

subtropical rain forest comes to the edge of the stream. On the banks are sedges, notably *Carex geminata,* and the fern *Blechnum capense,* which droops over the edges of pools. The rocks of the stream bed are derived from the underlying Manukau Breccia; the bed is colonised throughout the year by algae including the red alga *Bostrychia harveyi* and species of the filamentous green genera *Rhizoclonium* and *Cladophora.* During the dry summer months, woolly masses of the filamentous diatom *Melosira* sp. accumulate in the still waters of pools, and contribute significantly to interstitial detritus which is the main food of *O. wakefieldi* larvae.

From July 1965–November 1966 maximum-minimum thermometers at Station J measured water and air temperatures (Fig. 3). Maximum water temperature recorded was 25.0°C (February 1966) and the minimum 5.6°C (July/August 1965), a range of 19.4°C. Water temperatures paralleled air temperatures but had a narrower range.

Fig. 3 also shows monthly rainfall at the Waitakere Dam. Up to 40 mm of rain can fall before stream levels rise appreciably (V. M. J. de Bettencour, caretaker, Waitakere Dam, pers. comm.). Highest rainfalls were in August 1965 and February 1966; on 16–17 February 250 mm fell in 24 hours, water levels rose 3 metres above normal, and heavy scouring of the stream bed resulted. Bottom materials, especially the finer sands (<4 mm diameter) which form the preferred substrate of small *O. wakefieldi* larvae, were greatly affected by this flood.

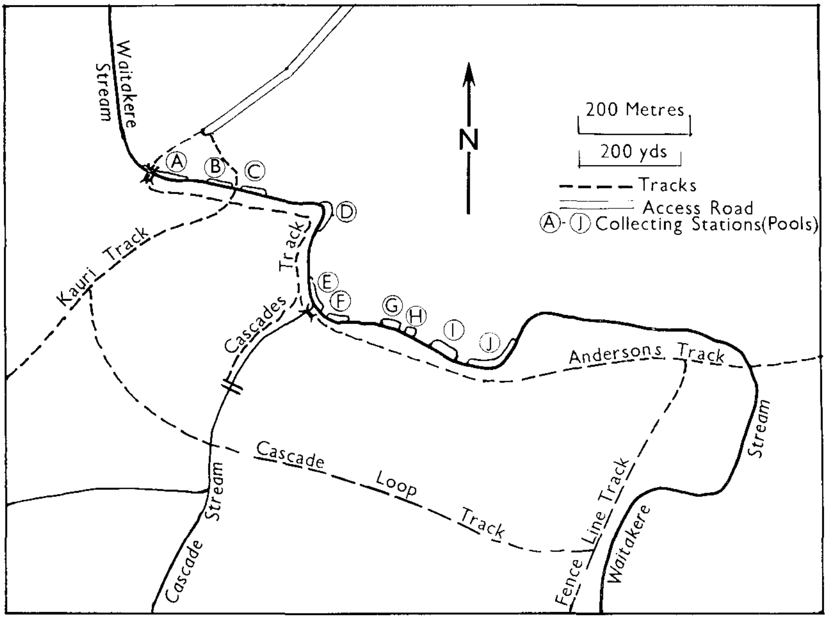

FIG. 2—Study area showing collecting stations.

METHODS

From July 1965 to October 1966, larvae were collected monthly from all Stations A–J (*see* Fig. 2) using a sweep net and a wide-mouth dragnet. The dragnet was 2 metres wide, 1 metre deep and constructed of terylene netting (12 meshes/cm). Before they were returned to the pool from which they had been taken, the larvae were measured exclusive of caudal filaments, from the front of the head to the hind edge of abdominal segment 10. The frequency of each size group, at millimetre intervals, was calculated as a percentage of each monthly sample. Numbers of individuals collected ranged from 20–108, with a mean of 46 per sample.

The span of the subimaginal period was determined from hand collections of final larval exuviae and winged forms. Light trapping proved ineffective (McLean 1967).

RESULTS

DISTINGUISHING CHARACTERS

The larvae of the two species which occur in North Island, *O. wakefieldi* and *O. distans*, can be distinguished by three main characters: *O. wakefieldi* has a conspicuous dark band across the caudal filaments, the tergum of segment 10 is smoothly rounded and there is a definite

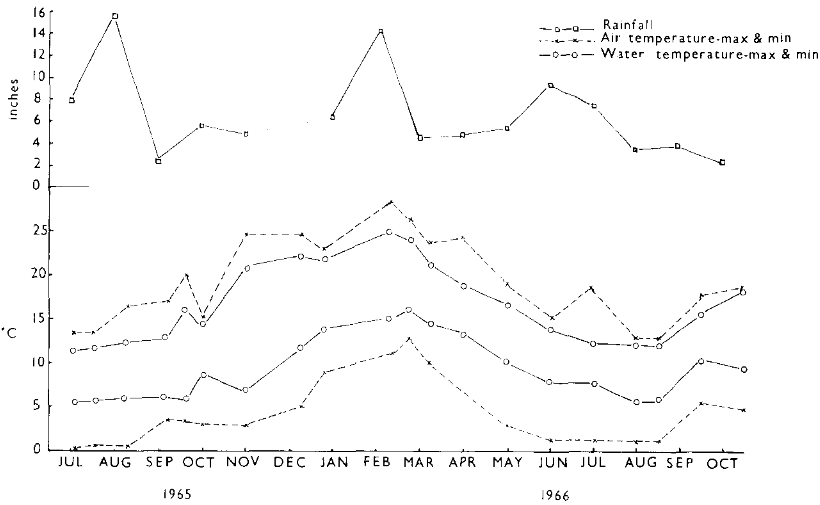

FIG. 3—Rainfall, maximum and minimum air and water temperatures for Waitakere Stream, July 1965–October 1966.

keel (known as the beak) on the clypeus; in *O. distans*, the caudal filaments are uniformly coloured, the tergum of segment 10 extends laterally to form two distinct projections and the clypeus is smoothly rounded (Fig. 4).

The status of a third species, *O. intermedius*, initially described on the basis of a single female imago by Eaton (1899) is uncertain; Penniket (1962) thinks it is probably synonymous with *O. wakefieldi*, as I do, after considering the variation in paranotal development of female imagos collected during this study. Larvae of the *O. intermedius* type figured by Phillips (1930) were found within the variation of the *O. wakefieldi* population in the Waitakere Stream; this is further evidence of the synonymy of these species, because it is unlikely that two very similar species would exist together in the same niche.

POPULATION STRUCTURE

Oniscigaster wakefieldi has a single brood each year (i.e., univoltine life cycle). The larvae emerge during 3 or 4 months from late October to early February. In late February, March, and April, populations contained only small larvae (<10 mm long) but the percentage of larger larvae gradually increased during winter to reach a maximum in early October. Smaller larvae were never entirely absent, however, implying a prolonged egg hatching period or slow growth of some larvae. From November to January numbers of larvae over 19 mm in length decreased because of emergence as subimagos.

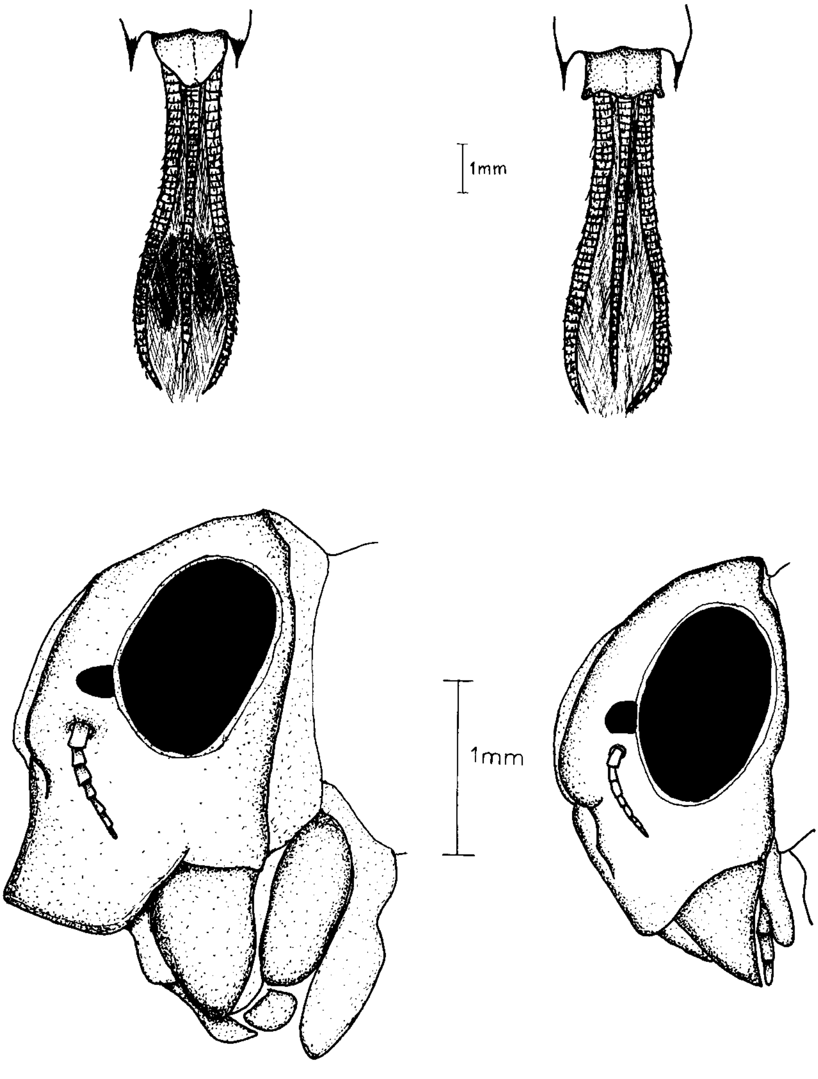

FIG. 4—*Oniscigaster wakefieldi* (left) and *O. distans* (right), (above) tergum 10 and caudal filaments, (below) lateral view of the heads of 18 mm larvae (*O. wakefieldi*—left—specimen ex alcohol slightly distorted by imbibition of water).

LARVAL INSTARS

In the kite diagrams two dominant larval size groups cause double bulges which allow the larval growth rate to be estimated by following their progress from month to month (Fig. 5). The rate of increase in body length of larvae >10 mm long appeared to be fairly constant at about 2 mm/month. Observation of marked larvae in an aquarium maintained below 18°C showed that individuals moult about once every 2 weeks with a net gain of 1mm in length each time. From these observations and by counting the number of rings in the Palmen's body (a concentrically layered structure associated with the tracheal system in the head of the larva which increases by one layer after each ecdysis—Landa 1942), I calculated that there are between 20 and 25 larval instars.

SEXUAL DIMORPHISM

Fifty-two exuviae of the final larval instar (collected from emergent boulders in the stream between October 1966 and January 1967) were measured. Average body length of female exuviae was 25 mm compared with 21 mm for males (Fig. 6). This dimorphism showed up in the larval population as early as May (larvae at 13–15 mm) when two distinct bulges in the upper part of the kite-diagram (*see* Fig. 5) first occur. The sex ratio derived from collections of final larval exuviae was 28 ♀ : 24 ♂, which suggests that equal numbers of males and females were emerging.

HABITAT PREFERENCES

Larvae of different size groups have preferences for different substrates. *Group 1* larvae (<10 mm long) occur in greatest numbers on silt and sand (0.4–4.0 mm diameter), particularly on sandbanks in shallow water (1–10 mm). Using a Surber sampler of 930 cm^2, 550 larvae/m^2 were found on a sandbank at Station E; other high concentrations were also found at Stations G and H. There are several ways in which this could happen: possibly the eggs are laid in such places (but oviposition has never been observed), or newly-hatched larvae actively seek a suitable substrate, or the eggs (which do not stick to stones) are stream-sorted into the finer sands and silts of density similar to their own.

Most *Group 2* larvae (11–18 mm long) are found among pebbles (4.0–40.0 mm diameter) set in a sand/silt matrix. Larvae in an aquarium often burrow into the underlying sands and silt, where they probably rest, remaining still except for ventilating movements of the gills. Possibly this is why "identical tow" samples (at Stations A, B, and G, depth about 50 cm) in some months yielded up to 60 specimens/m^2 but only a very few in the next. However, the current constantly redistributes loose substrate and this may also have an important effect on larval distribution.

Most *Group 3* larvae (>19 mm; at or near last instar) are found at the head of pools near riffles from which boulders emerge.

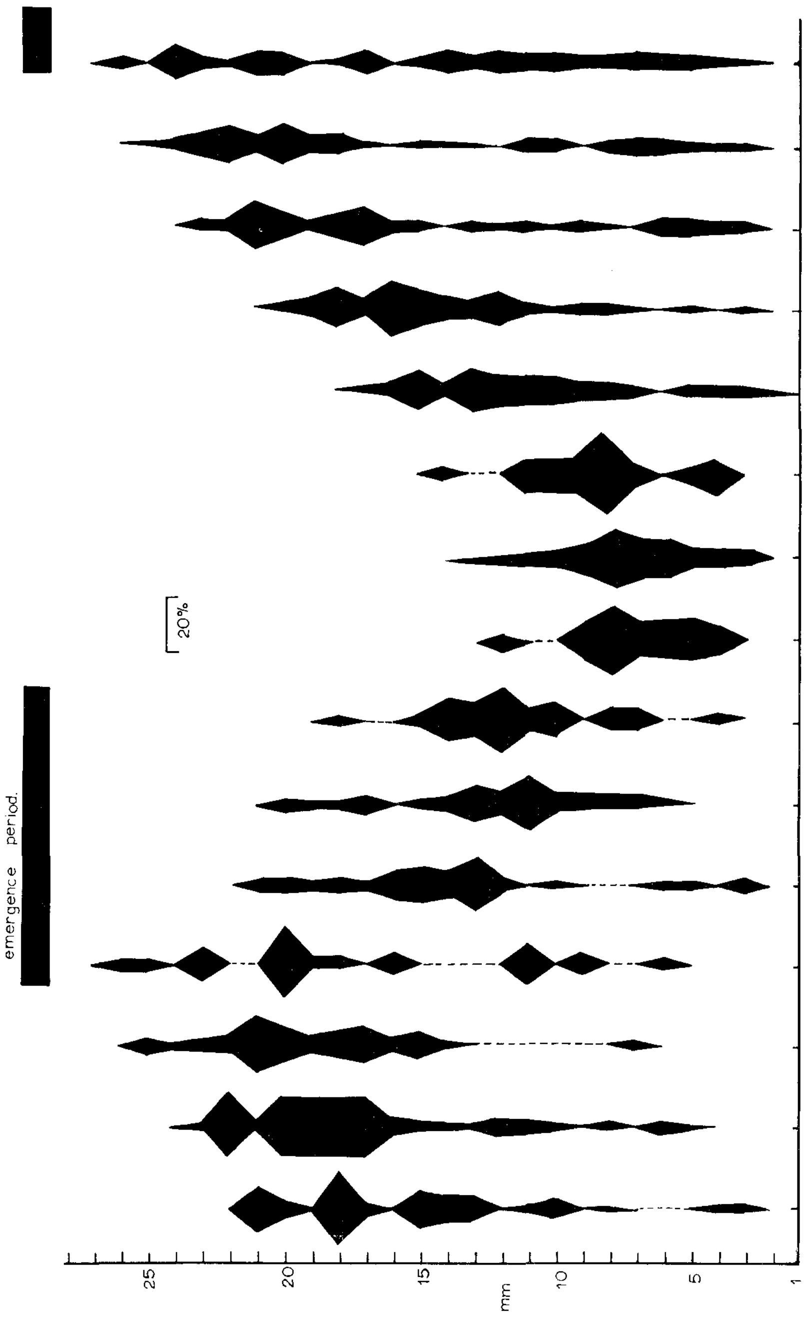

FIG. 5—Monthly analysis of lengths (excluding caudal filaments) of *Oniscigaster wakefieldi* larvae in Waitakere Stream 1965–66.

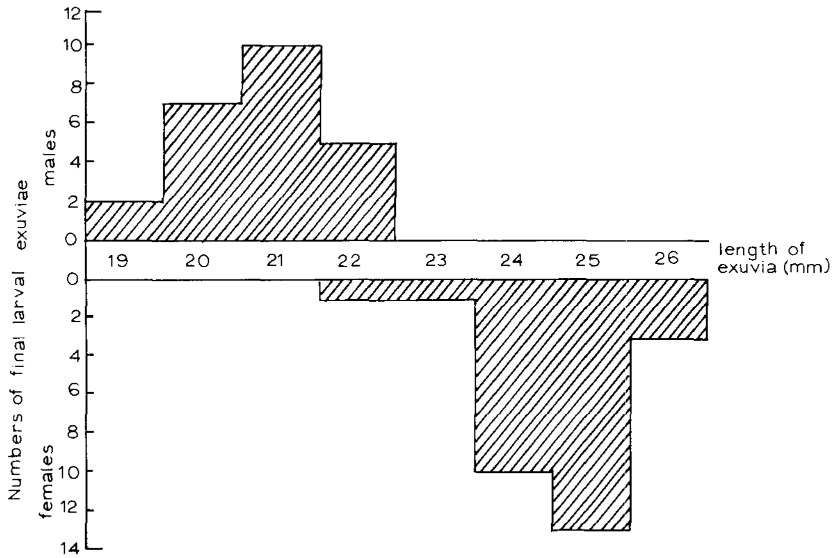

FIG. 6—Histogram of lengths of final instar exuviae of *Oniscigaster wakefieldi*, males and females separated, collected 1965–66.

DISTRIBUTION

In the North Island, *O. wakefieldi* has a patchy distribution (Fig. 7). It is restricted to regions of Paleozoic or Mesozoic sedimentary rocks and andesitic or basaltic volcanic rocks. Streams draining such areas usually carry little silt; as in the study area, larvae are normally found in gravel-bottomed pools flanked by native bush.

DISCUSSION

O. wakefieldi is usually thought of as one of New Zealand's rarer mayflies, probably because the swiftly darting larvae evaded the handnets used by earlier workers. A wide-mouthed dragnet (as used in this study) surmounts this difficulty because the larvae's movements rarely take them far enough to save them from it. Surveys of streams made throughout North Island, New Zealand, using this technique, show that *O. wakefieldi* is much more widespread than previously supposed.

The general form of the life cycle is similar to that of *Coloburiscus humeralis*, the only other New Zealand mayfly whose life cycle has been studied (Wisely 1965). It is univoltine with maximum larval emergence in the spring. Other insects studied in streams of the Waitakere Ranges, the two stoneflies *Zelandoperla maculata* and *Aucklandobius trivacuatus*, also have univoltine life cycles (Winterbourn 1966).

In the Waitakere Stream, very small larvae (<4 mm) of *O. wakefieldi* are present for 9 months of the year; Macan (1957) found that English mayfly, *Rithrogena semicolorata*, showed the same phenomenon:

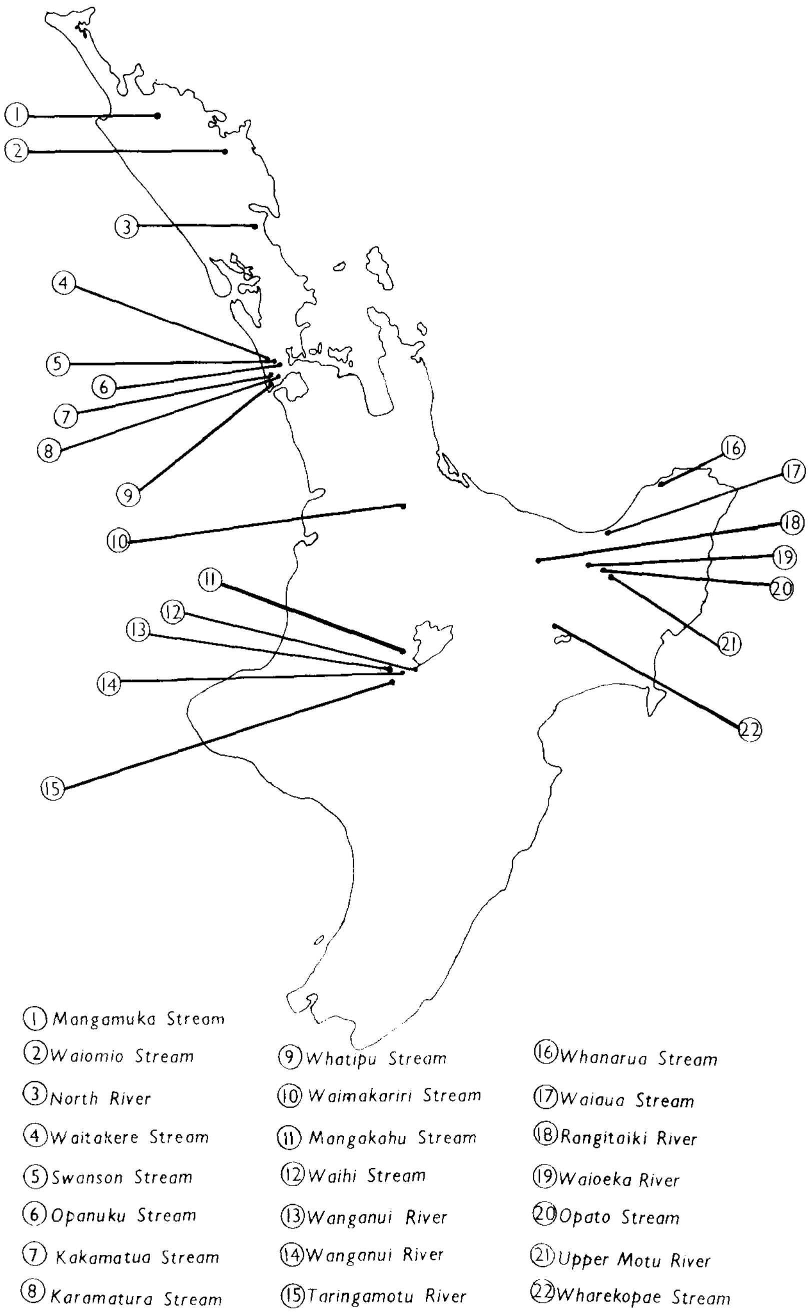

FIG. 7—North Island, N.Z., showing localities where *Oniscigaster wakefieldi* larvae were collected.

"Small nymphs, 1 to 2 millimeters long, were found over a period of 6 months. The most likely explanation is that there is a big variation in the duration of the egg stage." Because the emergence period of *O. wakefieldi* lasts only from October to early February, Macan's prolonged egg stage is also the probable explanation here.

There seem to be two major limiting factors affecting the distribution of *Oniscigaster*: First that the stream should have a low silt loading factor to prevent the gills of the larvae being fouled, and secondly that suitable vegetation, such as native bush, should adjoin the stream to provide protection for the aerial stages.

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