

INSECTS OF CAMPBELL ISLAND. PLECOPTERA¹

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Abstract: Campbell I. is inhabited by 3 species of stoneflies. They belong to 2 genera which are endemic in New Zealand and its subantarctic islands. The fully winged *Aucklandobius complementarius* End., is known from Auckland and Campbell Is. The 2 other species belong to the completely apterous genus *Apteryoperla* Wisl. and are endemics of Campbell. *Apteryoperla campbelli* Ills. is terrestrial in the larval stage and lives on the slopes of mountains (above 300 m), where both stages are encountered under stone. The ♀ of this species, hitherto unknown, is described. The 3rd species, *Apteryoperla longicauda* Ills., has aquatic larvae, which live in several streams of the island. The adults of this species are unknown. For the explanation of the existence of these Plecoptera on the Island it is necessary to assume a former land connection between Campbell (as well as Auckland) and the mainland of New Zealand. Since the breakdown of this land bridge the recent cool and wet climate must have been continuous on the island.

The only stonefly hitherto known from subantarctic islands was the endemic *Aucklandobius complementarius* End., taken in 1874 on the Lord Auckland Group by Krone on his German Scientific Expedition and described by Enderlein 1909. No members of the order Plecoptera have been recorded from Campbell I. before the material of the New Zealand "Cape Expedition" (a 1941-1945 Wartime operation, which established watching-stations on the islands, instructing personnel to collect insects in their spare time) together with some further material became available for study. This study (Illies, 1963b), stated the existence of three species of Plecoptera on the island.

Some additional material, which had been collected by Dr. J. L. Gressitt in 1961, was handed over to me for study. It gives more information about the Campbell I. species and includes the first fully mature adult of the terrestrial, apterous *Apteryoperla campbelli* Ills. So it is necessary to include more morphological details of this species, which was hitherto known only as larva and immature adult.

During February and March 1963, Mr. K. P. Rennell and Mr. K. A. J. Wise of Bishop Museum collected an abundant material of more than 300 larval specimens of Plecoptera from streams as well as from terrestrial biota. Wise, who systematically searched for stoneflies on various biotopes, has written a special report which is cited in this paper. These special activities have brought us to a rather detailed knowledge of the stonefly-fauna of the island and even of the distribution and the preferred localities of its species.

According to all this material, it becomes evident that the plecopteran fauna of Campbell I. consists of 3 species: 1) *Aucklandobius complementarius* End. is the only fully

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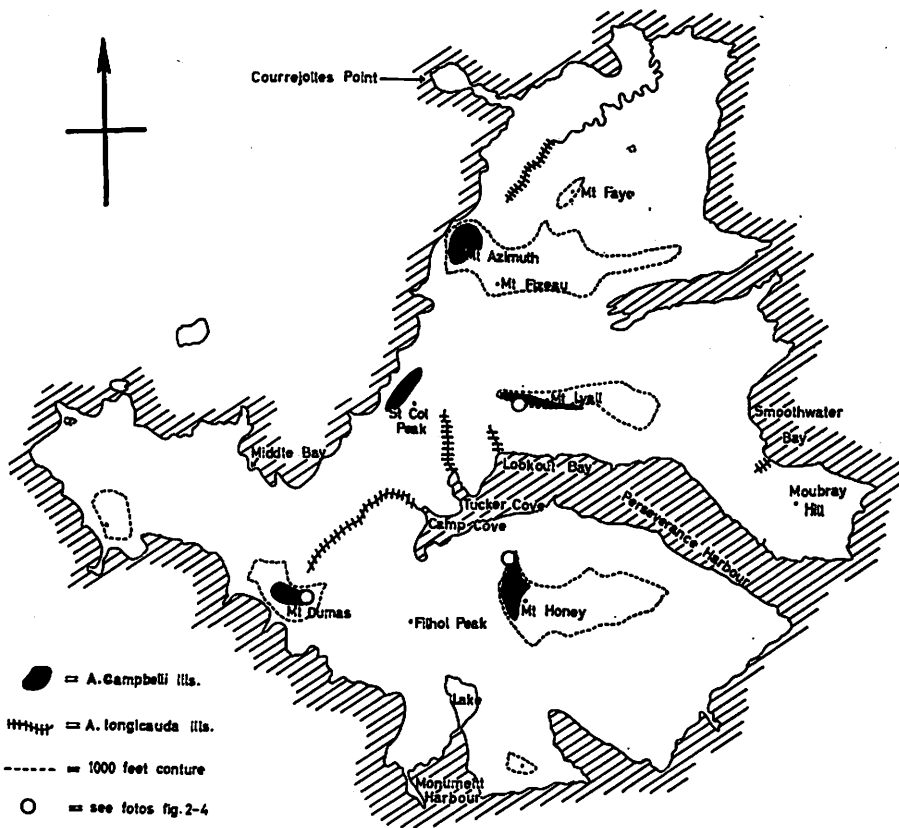


Fig. 1. Map of Campbell I. with distribution of the 2 species of *Apteryoperla* Wisl. The circles (see also figs. 2-4) indicate position of the lowest collection of *A. campbelli* Ills.

winged form of normal aquatic larval life; 2) *Apteryoperla campbelli* Ills. has terrestrial larvae and both stages are found under stones on the slopes of high mountains; 3) *Apteryoperla longicauda* Ills. inhabits some streams in the larval stage; adults are unknown but must be expected to live on the banks of these streams.

The 3 species, which are known to occur on Campbell I. are listed below. All Campbell I. records known to science are added.

1. *Aucklandobius complementarius* Enderlein

RECORDS: 2♂♂, Cape Expedition, ("Campbell Island"), 1943, J. H. Sorensen, (Dominion Mus.).

DISTRIBUTION: Known from Campbell and Auckland Is. only. Five more species of the genus (formerly included in *Nesoperla* Tilly.) are known from New Zealand.

Ecology: Fully winged species presumed to be active on the wing. Larvae live in streams, adults (on Auckland) have been taken under stones on the banks of streams. The species seems to be very rare on the island.

Remarks: The numerous material of nymphs out of streams, which has been collected by Wise and Rennell in 1963, includes no specimen of this species. This is all the more astonishing as a month earlier Wise found several larvae with wingcases in the Auckland Is. which certainly belong to this species.

Unfortunately it is not known at what part of the island Mr. Sorensen in 1943 found the 2 adults, which are the only known representatives of *Aucklandobius complementarius* End. on Campbell I. It must be supposed that the existence of the species on Campbell I. is restricted to an area which has not been examined by recent expeditions. But this idea is not satisfactory when dealing with a fully winged species whose chances of dispersal on the island are great. On Auckland Is. larvae have been found in several streams near sea level. Therefore it is difficult to understand, why collectors on Campbell I. did not succeed in finding them.

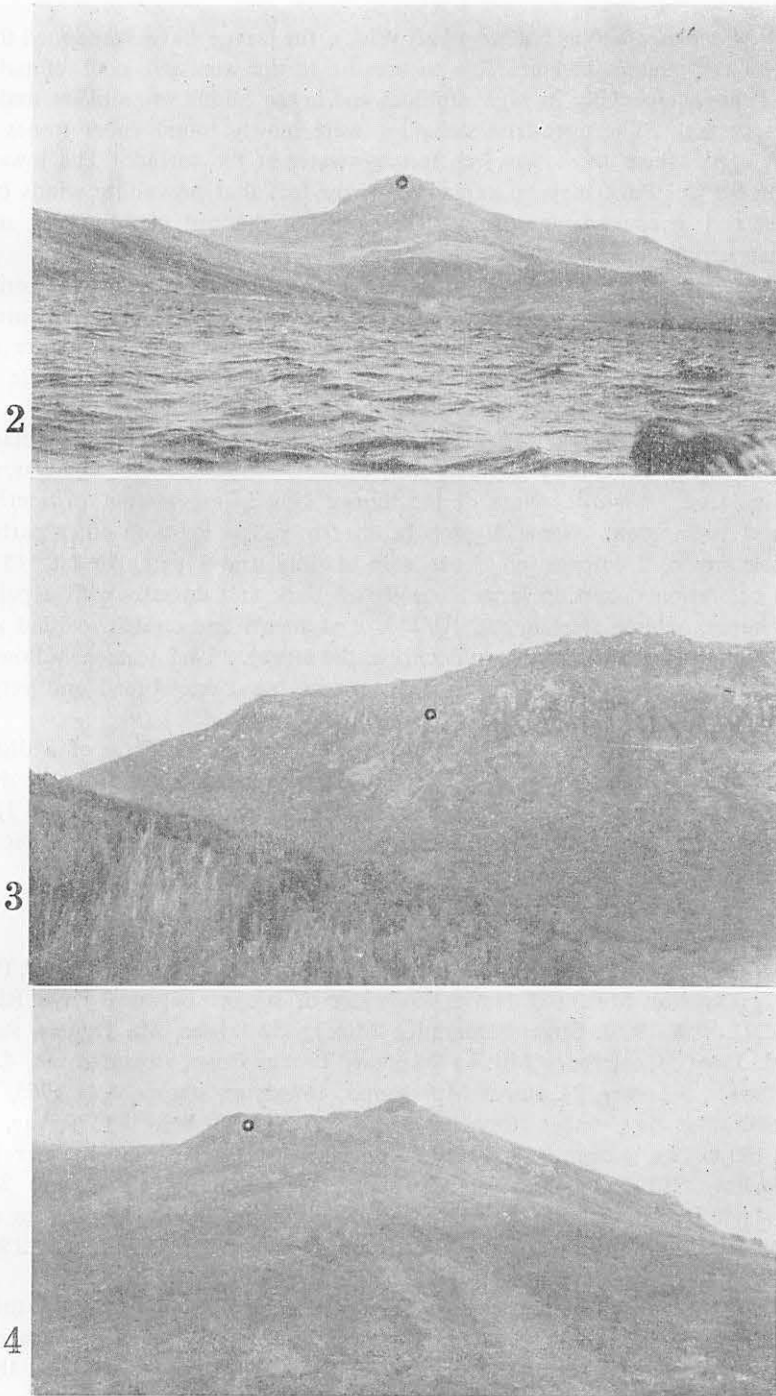
2. *Apteryoperla campbelli* Illies

RECORDS: 1♂, Cape Expedition, ("Campbell Island"), 1941, E. W. Mitchell & R. F. Wilson (Dominion Mus.); 5 larvae, Mt. Azimuth, under stones nr. summit, 17.I.1961, P. M. Jones, (Canterbury Mus.); 1♀, 16 larvae, Mt. Lyall, 200–400 m, under rock, 3, 5, 12. XII.1961, J. L. Gressitt (BISHOP); 11 larvae, Mt. Lyall, 200–400 m, under stones, 5.XII.1961, Gressitt, (BISHOP); 13 larvae, Mt. Dumas, above 400 m, under stones, 6. II.1963, K. A. J. Wise; 1 larva, *ibid.*, 460 m, under stone in moist area, 6.II.1963, K. P. Rennell; 3 larvae, Summit Mt. Dumas, 315 m, 6. II.1963, Wise; 12 larvae, N. side Mt. Azimuth, 480 m, under stones, 12. II.1963, Wise; 1 larva, N. ridge Mt. Azimuth, 440 m, under stone, 12. II.1963, Rennell; 16 larvae, SW slopes Mt. Lyall, 280–375 m, under stones, 19. II.1963, Wise; 14 larvae, SW slopes Mt. Lyall, 310–390 m, 19. II.1963, Rennell; 4 larvae, W. slopes St. Col Peak, ca. 180 m, under stones, 23. II.1963, Wise; 31 larvae, N. slope Mt. Honey, ca. 310–326 m, gap in bluffs, 24.II.1963, Wise; 15 larvae, *ibid.*, 415–480 m, 24.II.1963, Wise (BISHOP); all Campbell I.

DISTRIBUTION: Endemic species for Campbell I. Distribution shown by map (fig. 1). High elevations about 300 m are inhabited on several places, especially Mt. Dumas, Mt. Lyall and Mt. Honey (see photos in fig. 2–4). The respective part of the report of K. A. J. Wise, who so successfully collected this species, is as follows: "Terrestrial stoneflies were systematically searched for when climbing or moving about high areas. On the hills surrounding Perseverance Harbor a hard rock stratum outcrops as a series of bluffs 30–60 m in height reaching to approximately 305 m. Stoneflies were not found below these bluffs but were taken between and or above them at ca. 310 m on Mt. Honey, ca. 400 m on Mt. Dumas, and ca. 280 m on Mt. Lyall, on slopes above Perseverance Harbor. Stoneflies did not occur on hills not reaching above 305 m, Mt. Filhol 287 m, Beeman Hill 198 m, Moub-ray Hill 249 m, except for St. Col Peak 300 m, where they were found on the western slopes at only ca. 180 m."

During a trip made from Tucker Cove over Mt. Azimuth and along the western cliff-tops to Courrejolles Point, at the NW end of the island, terrestrial stoneflies were only found between 440 and 480 m above bluffs on the N. slopes of Mt. Azimuth.

Ecology: The species is completely apterous. Adults as well as larvae show morphological adaptations to semi-terrestrial life (shortening of cerci, reduction of gill tufts, see fig. 5c). Similar to the respective species of the genus on Auckland (*A. turbotti* Ills.) and on



Figs. 2-4. 2, Mt. Dumas (503 m) from NE. Small circle (see map fig. 1) indicates the lowest collection of *A. campbelli* Ills.; 3, Mt. Lyall (412 m) from S. Circle indicates lowest point of collection of *A. campbelli* Ills.; 4, Mt. Honey (568 m) from W. Circle indicates the lowest collection of *A. campbelli* Ills. Photo: K. A. J. Wise.

New Zealand (*A. monticola* Wisl., *A. angularis* Wisl.), the larvae have abandoned the aquatic environment of the streams and are able to breathe in the wet and cool climate of the subantarctic steppes, especially in high altitudes and in the humid atmosphere under stones.

Mr. Wise reports: "The terrestrial stoneflies were mostly found under stones on small bare areas of earth where there was free seepage water at the surface. The lower altitude occurrence on St. Col Peak may be explained by the fact that prevailing winds blow from the southwest and in consequence the western slopes of this hill may be kept more cold and wet than surrounding areas."

Additional description: Of this species only 1 adult was known, when the original description was made (Illies 1963 b). As this adult was a ♂ and not fully mature, nothing is known about the genitalia of the ♀ and about the color pattern of the mature adult. In the material collected by Dr. Gressitt a mature ♀ was found and it is possible therefore, to give the hitherto lacking details of the morphology of the species.

♀. 17 mm in length. Rather broad and stout (see fig. 6a) and brown to black in general coloration. Body completely covered with bristles. *Antenna*: 40 segments, somewhat longer than in larva. *Thorax*: Notum of the thorax broad, mesonotum distinctly broader than pro- and metanotum. Some lighter brown to yellow spots in outer parts of notum. *Legs* also dark brown, 2 patches on front side of tibia and 1 patch in 1st 1/3 of femur light. (Same coloration occurs in larva). *Abdomen* dark and dorsally with a pair of lateral yellow patches, which start in the 1st 1/3 of segments and stretch to hind margin in form of divergent stripes (same pattern occurs in the larva). Last segment yellow to brown in front, darkened in distal 1/2. Cerci of 13 segments, basal ones broad and very narrow, distal ones quadrangular (see fig. 6b).

External ♀ genitalia (as usual in the genus) only developed in form of a distinct concavity in hind margin of St. VIII (see fig. 6b). Subanal plates sheltered under dorsal prolongation of Tg. X. Cerci black in distal 1/2, light on inner edge of proximal 1/2. Maxilla (see fig. 6c) with very short distal segment of maxillary palp, which is typical for the genus.

3. *Apteryoperla longicauda* Illies

RECORDS: 1 larva, Cape Expedition, Tucker Cove, creek, 4 km from sea, 9. IV. 1946, J. H. Sorensen (Dominion Mus.); 1 larva, headwater of stream between Faye Ridge & N. W. Coast, 10. II. 1958, R. J. Street (Dominion Mus.); 52 larvae, Mt. Dumas, streams, 22. I. 1961, P. M. Jones (Canterbury Mus.); 2 larvae, Tucker Cove, stream rocks, 4. XII. 1961, Gressitt (BISHOP); 9 larvae, N. slopes Mt. Dumas, 160 m, ex stream, 5. II. 1963, Wise; 25 larvae, Smoothwater Bay, under stones in stream, 16. II. 1963, Wise; 15 larvae, N. slopes Mt. Dumas, 160 m, ex stream, 18. II. 1963, Rennell; 161 larvae, Smoothwater Bay, NW slopes of Moubray Hill, 150 m down to 10 m under stones in small stream, 2. III. 1963, Rennell, Wise; 1 larva, Smoothwater Bay, ex pool in shore rocks (nr. stream outlet), 2. III. 1963, Rennell; 1 larva, Lookout Bay, Perseverance Harbor, ex stream, 2. III. 1963, Wise; 4 larvae, Tucker Cove, on stone in stream, 3. III. 1963, Wise.

DISTRIBUTION: Endemic species for Campbell I. Streams inhabited by this species are shown on the map (see fig. 1). Some other streams on the island obviously have no stonefly fauna. Wise in his report states: "Aquatic stoneflies were taken in the Tucker Cove and Lookout Bay streams near sea-level, at ca. 160 m in the Camp Cove stream on the northern slopes of Mt. Dumas, and at ca. 50 m in a streamlet on a steep open face

on the southwest slopes of Moubray Hill. All these streams empty into Perseverance Harbour. On the northern slopes of Moubray Hill a stream flows down an old slip into Smoothwater Bay and aquatic stoneflies were taken in this stream from ca. 150 m down to the shore rock platform where one specimen was taken in a small pool adjacent to the stream outlet. Stoneflies were not found in streams at Middle Bay and on the southern slopes of Mt. Azimuth, or in the outlet stream from the lake at Monument Harbour."

Ecology: Completely apterous. Larvae live in streams and have never been found outside of water. Well-developed gill tufts and long cerci (fig. 5 a, b) prove, that the larvae are fully adapted to aquatic conditions. The rich material on hand shows that this species is rather numerous in streams. Variation in size of larvae is remarkably great. Ninety-three specimens of the greatest sample (Smoothwater Bay-Stream, 2. III. 1963, Rennell) have been measured and found to belong to the following size-classes (length of body without antennae and cerci):

4 : 2.5 mm	4 : 6 mm	5 : 12 mm
13 : 3 mm	2 : 6.5 mm	3 : 13 mm
3 : 3.5 mm	3 : 7 mm	3 : 14 mm
13 : 4 mm	3 : 8 mm	1 : 15 mm
6 : 4.5 mm	3 : 9 mm	2 : 16 mm
6 : 5 mm	6 : 10 mm	1 : 17 mm
4 : 5.5 mm	6 : 11 mm	1 : 21 mm

This pattern of size-classes can only be interpreted by the assumption that the development of the larvae takes more than 1 year and consequently, different year-classes of the species are represented in the same sample. Adults from subantarctic islands have only been found in December and early January. It must be because of this, that no adult was found during the intensive collecting-work on the island in February and March 1963. Coming to the banks of streams in mid-summer (December) one should find the adults of this species under stones and on rocks.

General conclusions: The family Gripopterygidae, to which the genera *Aucklandobius* and *Apteryoperla* belong, is restricted to the Southern Hemisphere and is richly developed there (30 genera with about 60 species). The members of the 4 subfamilies of this family have extended their range of distribution far to the South and represent the order on the southern tips of Australia, New Zealand, South America and on the subantarctic territories. Tierra del Fuego, as I have shown recently (Illies 1963a) has a rather large complement of Plecoptera, which was obviously recruited out of the rich number of nearby Patagonean species.

The rest of the subantarctic islands seem to have no Plecoptera. They have never been recorded from the Falkland or Kerguelen Is. in spite of extensive collections made there, and also the recent investigation of Macquarie I., according to Gressitt brought no evidence of stoneflies. On Chatham I., however, stoneflies are said to be present (Gressitt 1961), but nothing in detail is known about them in the literature and there remains some doubt until they have been extensively studied.

So it is just Campbell and Auckland of all subantarctic islands, which are known with any certainty to be inhabited by stoneflies. The complement with 3 species of this order on Campbell I. must be called rather rich. These 3 species (as well as those from Auckland) belong to the genera *Aucklandobius* End. and *Apteryoperla* Wisl. (family Gripopterygidae,

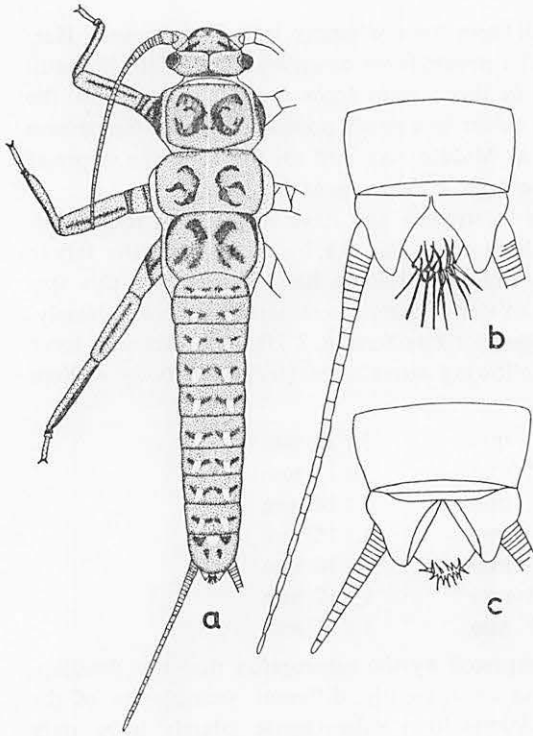


Fig. 5. a, *Apteryoperla longicauda* Ills., full grown larva (length of body ca. 20 mm); b, tip of abdomen of same specimen, ventral view; c, *A. campbelli* Ills., tip of abdomen of full grown larva, ventral view.

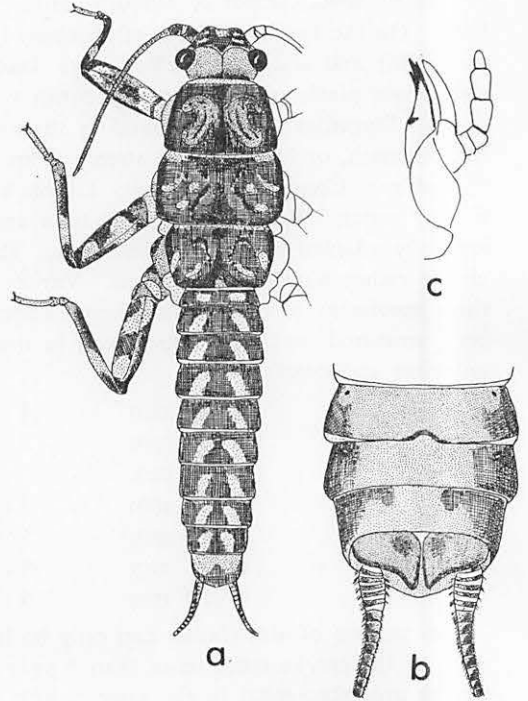


Fig. 6. *Apteryoperla campbelli* Ills., adult ♀. a, whole specimen, dorsal view; b, abdominal tip of same specimen, ventral view; c, left maxilla, ventral view.

subfamily Leptoperlinae), which are otherwise restricted to New Zealand. Thus the close relationship between the mainland of New Zealand and its subantarctic islands as well as the status of the whole territory as a faunistic subregion of its own can be stated anew.

The species of the genus *Aucklandobius* End. are fully winged and probably active flyers. The dispersal of specimens by wind may be improbable over distances such as 450 km, but as Gressitt (1961) has shown in a series of trapping experiments, few individuals of various orders of insects (no plecopteran up to date), occur in the wind drift in much greater distances from land. As *Aucklandobius complementarius* End. is endemic common to Auckland as well as Campbell I., the theory of such mode of dispersal must be seriously considered as an explanation of its occurrence on both islands.

In *Apteryoperla* Wisl., however, all species are completely wingless. There is no means of passive dispersal (therefore, transportation on sea, by birds or by man can be excluded), and we have to postulate a former land connection between the isolated areas of the recent representation of this genus. Gressitt (1961) does not agree in all cases with this type of reasoning and mentions, that "material reduction in wing size can take place in a few tens of thousands of years and that the rate of wing reduction is more rapid on islands that are smaller and subject to adverse weather conditions." This may be true in cases

where an endemic wingless species of an otherwise fully-winged genus occurs on an isolated island, especially if the fauna of the island lies under the permanent pressure of wind selection. But it must be emphasized, that all members of *Apteryoperla* Wisl.—on the mainland as well as on the islands—are wingless, while the rest of the Plecoptera in these territories are fully-winged. Absence of wings, therefore, is a common character of the genus (which, according to some further morphological details forms a well-defined phylogenetical unit), and if we postulate a dispersal by flight, it must have been the flight of an ancestor of the whole genus. The genera, however, are very old units in Plecoptera, especially in the archaic family of Gripopterygidae, and their origin must be placed in the Mesozoic. The order Plecoptera is known from the Permian (of Australia and Russia) and members of the family Gripopterygidae are present in the Southern Hemisphere since Jurassic to Cretaceous times at least. There is no reason, therefore, why the origin of *Apteryoperla* Wisl. could not have taken place in Mesozoic territory which includes New Zealand and its later isolated subantarctic islands. This is, according to my opinion, the most reasonable explanation for the recent distribution and separation of the genus.

Assuming this to be true (to which I see no alternative), we are able to learn something of the climatic history of these islands. It can be stated that the Plecoptera are revealed to be very useful tracer organisms for the study of the climatic and geological history of isolated territories. The presence of terrestrial species of *Apteryoperla* on Campbell I. (as well as on Auckland and New Zealand) shows that within this genus there is a general trend to the evolution of such forms under suitable conditions of high, subantarctic latitudes. It shows moreover, that considering the fact that this species has remained on the island since Mesozoic times, the favorable conditions for the terrestrial larvae, *i. e.* cool and wet climate, must have lasted continuously in at least some places of this island since the time when the land connection with the mainland disappeared. And as the 3rd Plecoptera of the Island, *Apteryoperla longicauda* Ills. is clearly aquatic and obligatorily related to the existence of courses of running fresh water, we can furthermore postulate that the existence of such permanent, running fresh water environments on the Island must also have lasted at least since the breakdown of land connections. All severe volcanic activities or more general changes of climate, therefore, can be excluded from the whole history of Campbell I. considering its plecopteran fauna.

I am greatly indebted to Mr. K. A. J. Wise for his invaluable information as well as for the photographs and a corresponding map of the localities, which he kindly offered me for the preparation of this paper.

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