



Ribeira das três Voltas near Ribeira Chã, São Miguel (Azores). Locality 35. Among the vegetable debris along the shores of the stream 23 species were collected (vide list p. 49). This was the quantitatively richest sample obtained in these islands. Photo P. Brinck & E. Dahl.

ON THE EPHEMEROPTERA OF THE AZORES AND MADEIRA¹

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With 3 plates

The mayflies are very poorly represented in isolated islands. Therefore, it was rather astonishing to meet with these insects at several localities in the Azores as well as in Madeira. The examination of the material revealed, however, that only a few species were represented, and they were found to be well-known and wide-spread.

Ephemeroptera from the Azores

There is only one record of a mayfly from these islands, viz. Navas, Ann. Soc. Ent. France 102, 1933, p. 20: *Cloëon dipterum* (L.) from São Miguel, Furnas. The specimen had been collected by Drs. L. Chopard and A. Méquignon in August—September 1930. In the present material the species is represented by a number of specimens.

Cloëon dipterum (Linnaeus, 1758) s. Bengtsson, 1914.

São Miguel: Charco da Madeira, 6 km. N of Ponta Delgada, 1.III. 1957. Loc. 4: Remains of a small lake, situated in a shallow depression in open country (pasture); bottom volcanic sand and mud; dense aquatic and semi-aquatic vegetation; pH 7.0, water temp. 13° 7 (air temp. 13° 6 C). 1 nymph.

São Miguel: Fonte Grande SE of Feteiras, 6.III.1957. Loc. 12: Water trough of cement, filled from a spring (rheocrene); many algae and

1) Report No. 20 from the Lund University Expedition in 1957 to the Azores and Madeira.

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much plancton. On the surface of the water 3 nymphal skins and a cast skin of a subimago; on the walls 13 nymphs (various instars).

São Miguel: Pond 500m E of Lagoa do Pau Pique, 7.III.1957. Loc. 16: small and shallow eutrophic pond with a rich aquatic vegetation, situated in open country (pasture); muddy bottom; pH 6.4, water temp. 13.0°C (air temp. 11.0°C). Two medium-sized nymphs.

São Miguel: Tanque 1km SE of Lagoa do Congro, 16.III.1957. Loc. 33: Small, shallow pond in open country; water clayey, bottom clay and sand, vegetation *Juncus* and water-lilies; pH 6.4, water temp. 14.0°C at 11.45 (air temp. 14.1°C). Numerous nymphs were swept from the aquatic vegetation: 73 were collected, most of them full-grown or almost so, some medium-sized and a few small ones. In the material there are also 14 cast skins, 4 male and 13 female subimagines plus 1 male and 5 female imagines. During the collecting the weather was comparatively bad: There was no wind but dense fog and a drizzling rain. In spite of this the mayflies were emerging. The nymphs rose to the surface of the water, where they rested for a short while, until the insects left the nymphal skins 6-10 seconds after they had come to the surface. The subimagines still stayed on the surface for a few seconds until most of them took off. On taking off several of them were hit by rain drops and knocked down to the surface; others safely reached the vegetation on the shore where they took shelter. Imagines and subimagines were swept in bush and other low vegetation along the shore, but there was no swarming.

São Miguel: Fonte at Casas Telhadas (João Ramos), SW of Ribeira Grande, 18.III.1957. Loc. 36: Cemented basin (water trough) into which a spring emptied its water; algal vegetation and a fairly rich plancton; pH 6.7, water temp. 15.0°C at 10.15 (air temp. 15.1°C). On the walls of the basin 9 nymphs (various instars) and on the surface of the water 1 cast skin.

São Miguel: Spring at Ribeira das três Voltas, near Ribeira Chã, 23.III.1957. Loc. 50: Drying-up spring (limnocrène) forming two shallow basins with bottom covered with leaves; water temp. 18.7°C at 10.30 (air temp. 15.9°C). Five cast skins plus 1 male and 3 female subimagines.

São Miguel: Pico da Azeitona, NE of Ponta da Garça, 23.III.1957. Loc. 56: Small, shallow pond in open country; water clayey, without vegetation. Dense fog; air temp. 12.6°C. One emerging female subimago.

Santa Maria: 1 km W of Praia, 20.III.1957. Loc. 46 (pond I and

II): Small and shallow eutrophic ponds in open country (pasture). In pond I 3 old nymphs, in pond II 14 nymphs (various stages).

Faial: Flamengos, 3.IV.1957. Loc. 85: Pools with fairly dense vegetation and muddy bottom in the bed of the Ribeira dos Flamengos. Four nymphs.

Faial: 3 km WNW of Pedro Miguel, 5.IV.1957. Loc. 92: Temporary pool (100 × 20 yards), bottom covered with grass, surroundings open country (pasture). One almost full-grown and 4 medium-sized nymphs.

Ecological Notes on the Species.

The aquatic habitats of the Azores can be classified roughly into four groups: springs, streams, lakes and man-made basins or pools. The first-mentioned three habitats are natural. There is no sample of Ephemeroptera, collected at an undisturbed, natural habitat in the Azores. Almost all the localities listed above consist of tanks or pools constructed by man as water reservoirs (mainly for cattle). When mayflies were collected at a spring (loc. Nos. 12, 36 and 50), they never occurred in the outflow, but lived in a water trough or basin draining the spring.

Numerous streams were examined almost all over the Azores, but Ephemeroptera were met with in one only, viz. in the Ribeira dos Flamengos, where a short series of nymphs occurred at the village of Flamengos, in pools which were heavily influenced by man.

The species was particularly common in small eutrophic ponds in pasture land; such ponds are very common in the Azores and were usually constructed to retain rain water for the cattle.

It is remarkable that no Ephemeroptera were collected in the numerous natural lakes of the islands. This might be due to the fact that the lakes are more or less oligotrophic with open shores and little vegetation.

In any case it is evident that in the Azores *Cloëon dipterum* lives in habitats, created by man. From an ecological point of view, this is hardly astonishing. It is well-known that the species prefers eutrophic ponds with a rather high summer temperature and when met with in streams, it always lives in slow-flowing stretches with a fairly dense aquatic vegetation. Its presence in water tanks has been recorded already by Eaton (1885, p. 186): «At Paris, tanks for Nymphaeaceae and other water-plants in the Jardin des Plantes are its favourite resorts». And in London it was found

to breed freely in static water tanks during the war (1941-45) (Kimmins, 1950, p. 9).

From the material listed above it seems that the main swarming period of the species occurs at the end of March and in April, although it is not clearly defined. In the populations there are young nymphs which probably do not emerge until summer. And the record by Navas indicates that imagines occur also late in summer (August-September). This agrees with conditions in Europe. In northern Europe imagines are met with from May to September and in France the species is on the wing from April to October (Verrier, 1950), in certain years «selon les conditions atmosphériques» it might even occur from March to November (Verrier 1956, p. 137). In the Canary Islands it was found to be common on Teneriffe in December (Eaton, 1885, p. 186).

The emergence of the species at midday, in dense fog and rain, is unusual, but might be due to the fact that it was dead calm. Usually, the islands are very windy.

The Geographical Distribution and the Dynamics of the Species

Cloëon dipterum is a Palearctic species which is common in Europe, from Scandinavia southwards to the border of the Mediterranean. There are old records from northeastern Africa but so far it has not been recorded from northwestern Africa. It occurs in Madeira and the Canary Islands (Eaton 1885). It is evident that the species has an unusual capacity to disperse, as it is often met with in tanks and other temporary habitats.

Its almost complete restriction in the Azores to habitats created by man or heavily influenced by human action, might indicate that the species is a fairly recent immigrant. This does not necessarily mean that the species arrived by flight; on the contrary, such a long transport of these tiny insects from Europe seems improbable; The distance from the nearest mainland (Portugal, Cabo da Roca) is about 1400 km. We know, however, that numerous water plants were brought to São Miguel and Faial from Europe in the 19th century and besides there are long lists of transports of eggs of various freshwater fish from England, Germany and Portugal to the Azores (cf. e.g. Barrois 1896, pp. 54-57), so there have been several opportunities for nymphs to be brought to the islands and distributed all over them.

This is certainly one of those few ephemeropteran species which are

easily spread by suitable human transports. The presence of the species in all the Macaronesian island groups might be regarded as an indication of its indigenuity. It should be remembered, however, that in all these islands the lakes and streams were almost devoid of vertebrates when man arrived there which brought on introduction of fish and frogs at numerous occasions. The material was almost always taken from Europe where *Cloëon dipterum* is common in fish ponds etc.

There will of course be no opportunity for us to fix the arrival of the species to the islands. But it is of some interest that two skilled investigators of Azorean aquatic habitats in the 19th century (de Guerne and Barrois) do not mention Ephemeroptera among their material. Barrois (1896) examined most of the water bodies of Santa Maria, São Miguel and Faial and should have met with *Cloëon dipterum* if it were as common as to day, although he specialised in Crustacea and lower invertebrates.

Ephemeroptera from Madeira

Although numerous entomologists have worked in Madeira, there are few records of Ephemeroptera from this island. Hagen (1865, pp. 25-26) described *Cloëon maderensis* from material, collected by Wollaston. Wollaston's material was revised by Eaton (1871, p. 15) who states that it contained 2 female imagines of *Cloëon dipterum* L. and 4 male + 2 female imagines and 1 female subimago of *C. maderensis* which he regarded as a synonym of *Baëtis rhodani* (Pictet).

In his monograph (1883-1888) Eaton again refers to these two species. For *Cloëon dipterum* he says (1885, p. 186): «Madeira, in pools left in the lower parts of the beds of streams in the neighbourhood of Funchal (22 Nov. 1880), first collected by Wollaston». *Baëtis rhodani* (1885, p. 162) is said to be «common in Madeira up to 3.000 ft.».

The present material was collected during a rather short stay at the island. Therefore, most of the time was spent in localities which were undisturbed or at least only moderately influenced by human action. The freshwater habitats examined are almost all mountain streams. *Cloëon dipterum* did not occur in these streams, so it seems that in Madeira like in the Azores it is restricted to garden ponds and pools in river beds close to human habitation.

The other species, however, is represented by a rich material, as follows.

Baëtis rhodani (Pictet, 1843-45)

Terreiro da Luta, alt. 850 m, 20.IV.1957. Loc. 112: Two torrential streams with clear water and stony bottom, coming down a mountain slope in fairly deep ravines. The species was common and numerous specimens were emerging. The following material was collected: 17 nymphs (length 2-7 mm), 2 male + 2 female subimagines and 1 male + 3 female imagines.

Arieiro Mountains, Ribeira das Cales, alt. 1300 m, 21.IV.1957. Loc. 113: Fairly exposed, small stream with clear water and stony and sandy bottom. The species was fairly common and had started emerging. The following material was collected: 8 nymphs, two of which were young, and 2 female subimagines.

Arieiro Mountains, alt. 1700 m, 21.IV.1957. Loc. 114: Narrow stream with cold and clear water, fast-flowing in stony and fairly deep ravine. The fauna was rich and very interesting. Ephemeroptera were fairly numerous and had been emerging for some time (on the banks and in back-water remains of imagines). The samples contain: 17 nymphs, 4 of which are small (1-3.5 mm) and the rest medium-sized or full-grown (4-9 mm), 1 cast skin, remains of imago.

Ribeiro Frio, 7 km SW of Faial, alt. 860 m, 21.IV.1957. Loc. 115: Fast-flowing stream with clear water and stony bottom, running through wooded valley. Six nymphs (3-8 mm).

Faial, at the mouth of Ribeiro do Faial, 21.IV.1957. Loc. 116: In narrow branches of the river, with some aquatic vegetation and fairly fast-running water, bottom stony or sandy. Ephemeroptera were fairly scarce: 2 nymphs (6.5-7 mm) and 5 male imagines were collected.

Ribeira Brava, at the mouth of the river, 23.IV.1957. Loc. 121: A female subimago was collected from the surface of the river.

Casa das Queimadas, alt. 880 m, 24.IV.1957. Loc. 122: Small stony stream in shallow wooded ravine, water clear and cool. 3 nymphs (7-9 mm).

Casa das Queimadas, Rib. d. Touros d. Solveira, alt. 890 m, 24.IV.1957. Loc. 124: Torrential stony stream with cool and clear water. The fauna was rich and contained several indigenous species. Ephemeroptera were fairly scarce: 2 medium-sized nymphs were collected.

Ravine near Ribeira das Cales, alt. 1200 m, 26.IV.1957. Loc. 127: Small shallow stream running through fairly open depression in mountain slope. Ephemeroptera were scarce: 2 fairly small nymphs were collected (3 and 5 mm).

Ribeiro Frio, deep ravine 8 km SSW of Faial, alt. 1000 m, 26.IV.1957. Loc. 128: Fast-running stony stream with clear water. One nymph (6 mm).

Ribeiro da Lapa, E of Pico do Serrado, alt. 900 m, 27.IV.1957. Loc. 132: Small stream, mainly consisting of basins connected by a trickle. Ephemeroptera were numerous. The nymphs were met with under stones in the trickle; subimagines and imagines were collected on the banks among the stones or in tufts of *Juncus* and grass. Two nymphs (4 and 6 mm), 2 cast skins, 10 male + 5 female subimagines and 4 female imagines. The subimagines were emerging.

Boca da Encumeada, alt. 1000 m, 28.IV.1957. Loc. 134: levada (aqueduct) passing steep mountain slope covered with dense bush. The water was running very fast after heavy rain. The species was emerging and the following material was collected: 3 male + 2 female subimagines and 1 male imago.

1 km E of Encumeada, alt. 800 m, 28.IV.1957. Loc. 135: Trickle in wooded ravine. One male subimago.

Ecological Notes on the Species

Baëtis rhodani is a characteristic element of the Madeiran streams. There is hardly a stony stream with clear, fast-running water which is not inhabited by this species.

Almost all over Europe it is common in stony streams and rivers, preferring swiftly flowing places and clear water. As demonstrated by Macan (1957) it can under optimal conditions occur in very large numbers in stony streams. Usually, the nymphal populations are composed of specimens of greatly varying sizes and subimagines can be taken in most months of the year. As is evident from the above material similar conditions seem to prevail in Madeira.

The Geographical Distribution and the Dynamics of the Species

Baëtis rhodani is a West Palearctic species, in Europe occurring from Scandinavia southwards to the borders of the Mediterranean. It has been recorded from Corsica (Eaton 1885, p. 162) but so far we have found no records from North Africa. It is also common in Gran Canaria according to Eaton (loc. cit., p. 162).

The great abundance of the species and its wide amplitude as regards

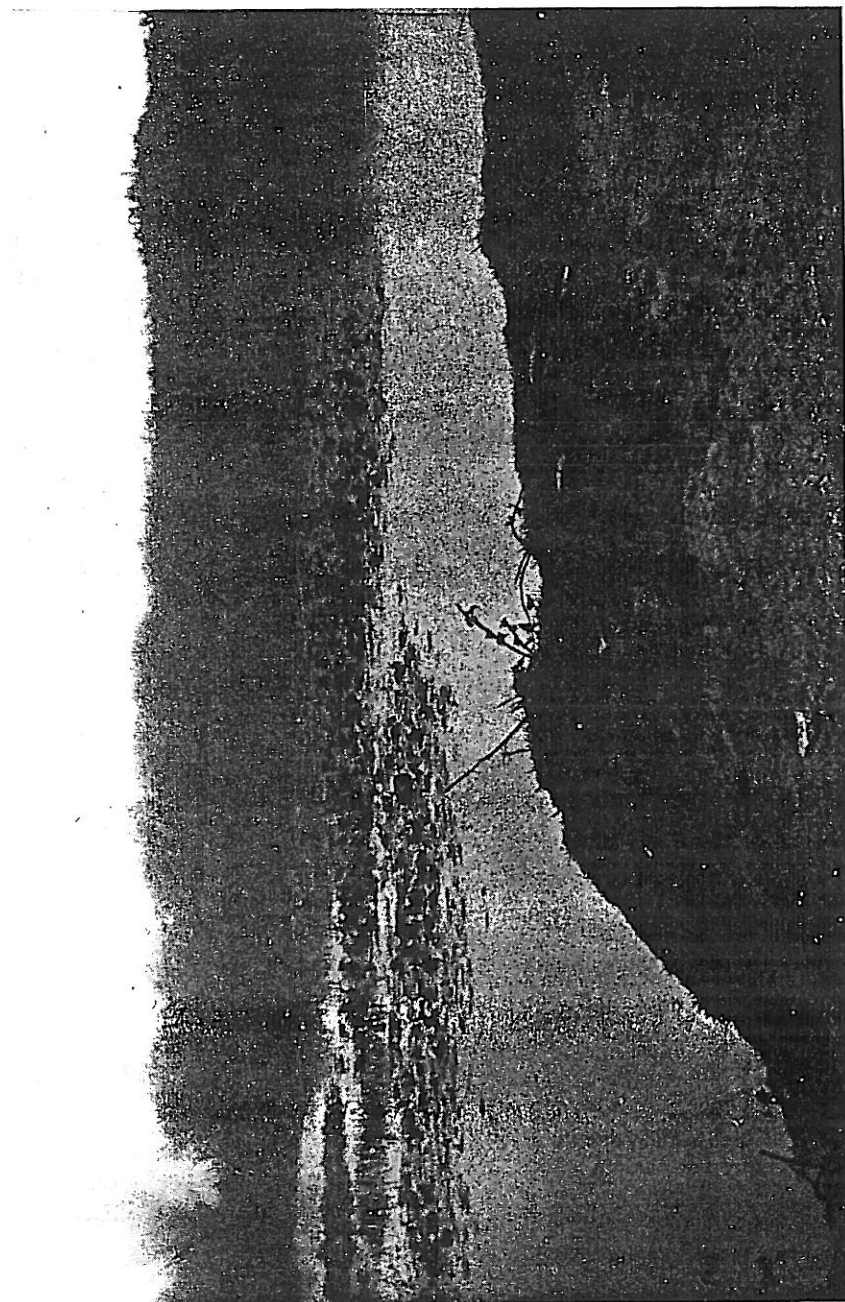
growth periods and emergence time involve potentials of dispersal which are unusual among Ephemeroptera. Wind dispersal of Ephemeroptera over considerable distances at sea, however, must be unsuccessful as a rule, as is proved by the general distribution of the group.

Madeira like the Canaries has a rich indigenous fauna, also among aquatic insects, so it might be that *Baëtis rhodani* belongs to the indigenous element of these islands, and invaded at one time under conditions which were more favourable than at present. In this connection it is of some interest that the species inhabits the undisturbed mountain streams, contrary to *Cloëon dipterum*.

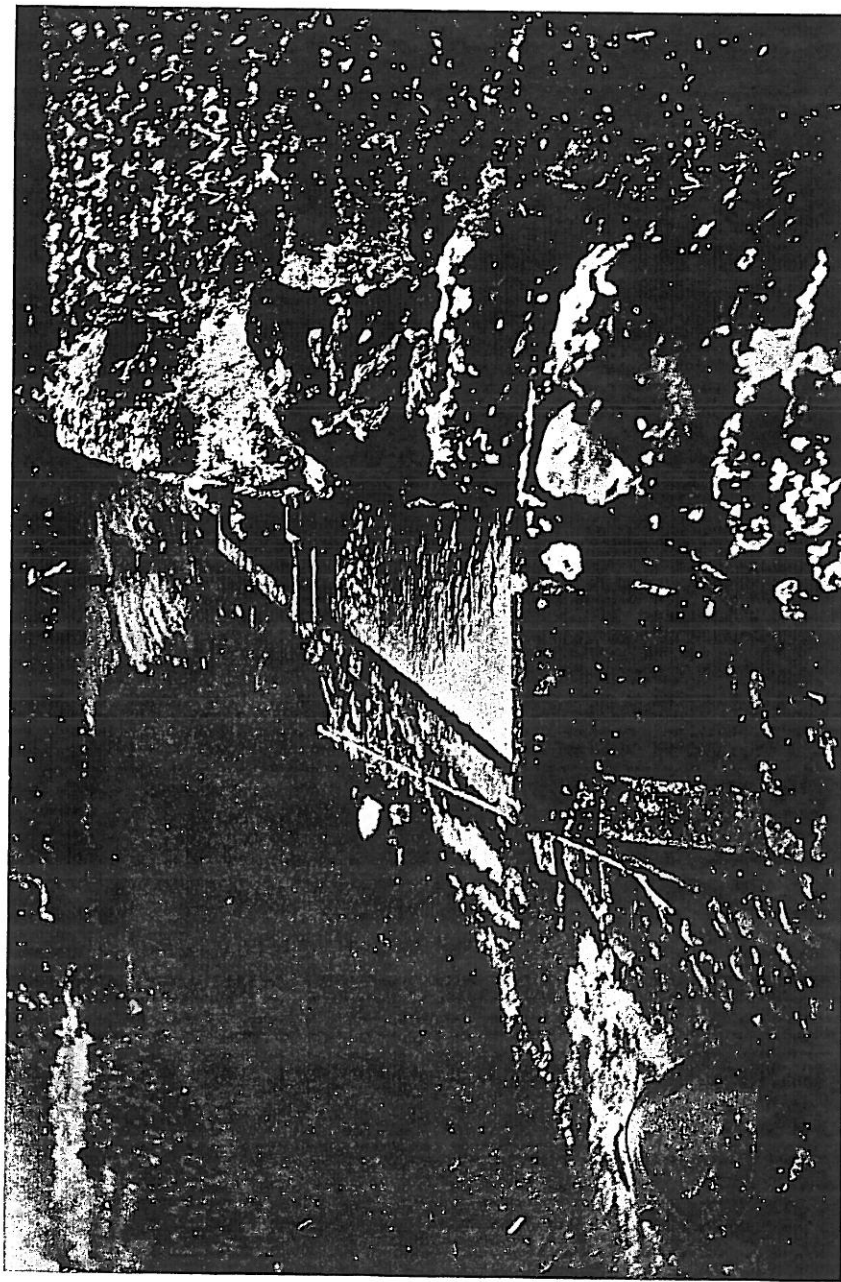
This does not mean, however, that introduction by man is excluded. As mentioned above there have been several opportunities for transport of ephemeropteran nymphs from western Europe to the Macaronesian islands.

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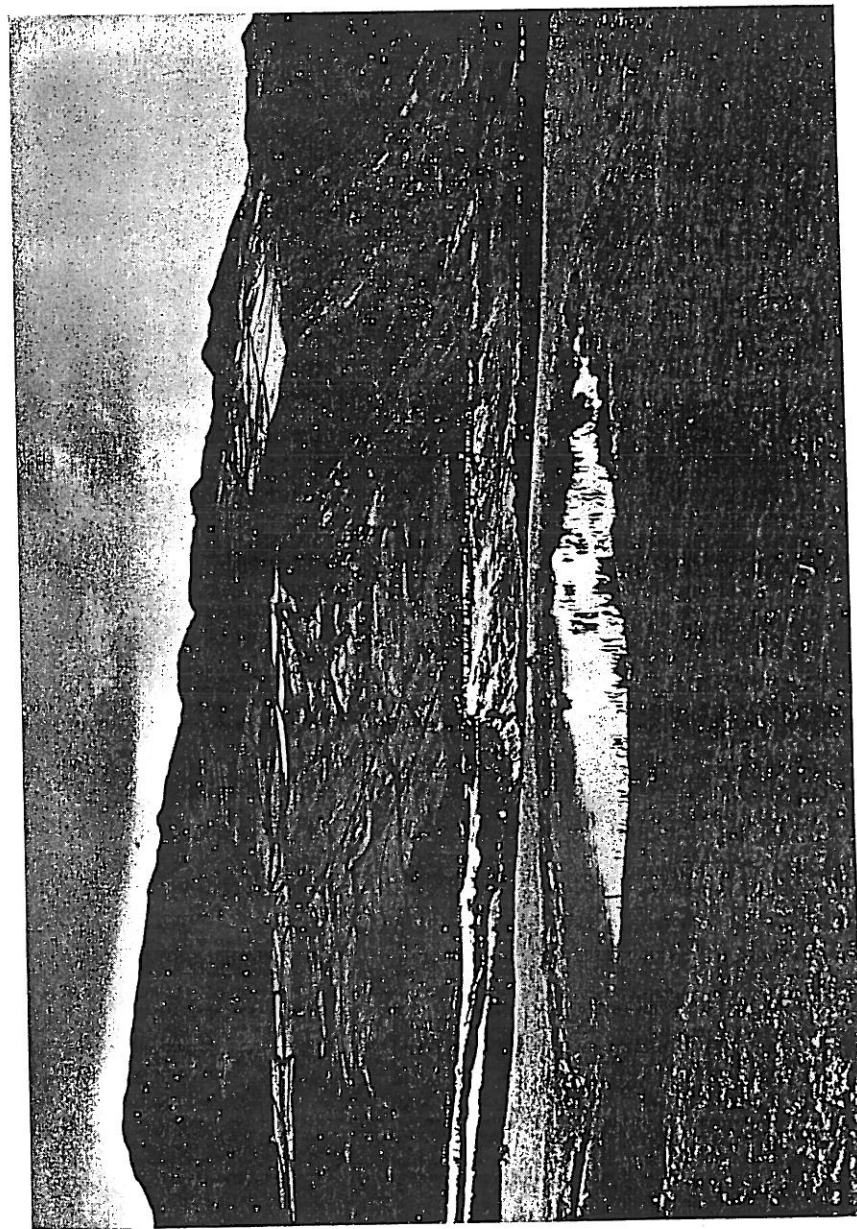
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Tanque 1 km SE of Lagoa do Congro (Azores: São Miguel), a pond where *Cloëon dipterum* L. was emerging on March 16, 1957, in dense fog and drizzling rain. (Photo P. Brinck).



Fonte at Casas Telhadas, SW of Ribeira Grande (Azores: São Miguel). Cemented basin inhabited by a population of *Cloëon dipterum* (L.). (Photo E. Dahl).



Pond, 1 km W of Praia (Azores: Santa Maria). A small and shallow eutrophic pond inhabited by a fairly rich, temporary fauna, including *Cloëon dipterum* (L.). (Photo P. Princk & E. Dahl).