RIVISTA di PARASSITOLOGIA
Vol. XXXVIII - N. 2/3 1977

CONTRIBUTION TO THE KNOWLEDGE OF THE MOSQUITO FAUNA OF THE NEW HEBRIDES ISLAND GROUP PROPER (DIPTERA : CULICIDAE)

MARIO MAFFI

Complementary to recent reports on Culicidae in the remnant parts of the Santa Cruz — New Hebrides faunal area, this paper relates on 2671 specimens of Culicidae (100 ♀ ♀, 29 ♂ ♂, 1902 larvae, 20 larval skins, 498 pupae, 102 pupal skins) resulting from 247 collections — most of them casual (no individual rearings) — made by the author in the New Hebrides island group proper during the dry seasons 1971 and 1975. Of a total of 22 species of Culicidae reported in the past from the New Hebrides proper, 17 were found: i.e. all the species except for those 5 which either are rare or have peculiar and uncommon breeding sites. The increase of the former record of insular presence of the species (138) to 232 has added considerable information on the distribution of the 17 species of mosquitoes in the New Hebrides proper. A few, pertinent details are given on morphology, bionomics and possible vectorial roles, a few comments are offered, and the relevant literature is reported.

INTRODUCTION

The Santa Cruz-New Hebrides area is one of the 6 mosquito faunal areas into which Belkin has subdivided the South Pacific (1962: 14-15, figs. 8, 19). The area represents a natural unit, since the island groups which are part of it, though apparently scattered over a large portion of the Southwest Pacific and separated by depths reaching over 1000 metres, are all located on the same submarine ridge of the New Hebrides, that is far away from but subparallel to the eastern coast of Australia (Fig. 1).

In two previous papers has been reported on the mosquito fauna of the more northern and isolated island groups of the Santa Cruz-New Hebrides area: first on the Santa Cruz group and Tikopia and Anuta islands, all in the Solomons (Maffi & Taylor, 1974), and more recently on the Banks and Torres group, in the New Hebrides Condominium (Maffi & Taylor, 1977). The present paper, complementary to the above ones, completes the coverage of the Santa Cruz-New Hebrides faunal area (except for a few remote and/or small and/or uninhabited islands), relating on the mosquito fauna I collected during the dry seasons 1971 and 1975 in the rest of the whole area, i.e. on those islands of the New Hebrides Condominium that are located south of the Banks, and which are usually called the New Hebrides islands group proper — henceforth: N.H.p. — (Belkin, 1962: 28-29, fig. 24).

Permanent addres: 16030 CAVI (*Genova*), *Italia*.

There is abundant general and specific literature on the New Hebrides Condominium, and material directly or indirectly related to the subject of this paper can be found, among others, in Buxton (1926), McArthur & Yaxley (1967), Oddo & Chang (1971), Maffi (1972, 1976), Corner & Lee (1975) and Ratard (1976). For detailed entomological information, however, one should refer to Buxton & Hopkins (1927), Rageau & Vervent (1958, 1959) and Belkin (1955, 1962, 1965). It is from the above literature that most of the background information for this paper has been drawn, and to it should refer any person interested in additional details.

Of the total land mass of the Condominium of the New Hebrides (11,859 km^2) the Banks and Torres group represent only 818 km^2, and of the total population (90,050 in 1974, estimated) only 3,940. Therefore, it can be said that in size and population the N.H.p. represent almost the whole Condominium. The resulting average density/km^2, 7.5, is of little significance, since island figures can vary from 0.7 on Erromango I. to 239.0 on the islets off Malekula I., and reach even 722.0 on Laman islet, off Epi I. (Ratard, 1976). Except for the possible Polynesian origin of a few hundred people living on Futuna I. and for a limited number of non-autochthonous persons, mainly in the major centres, the whole population of the N.H.p. is Melanesian.

The N.H.p. consist of a dozen major islands and of about 40 smaller islands and islets — the latter mainly just off the larger islands —, distributed over a wide area of the Southwest Pacific in a Y-shaped pattern, from northwest to southeast, and located from just north of 15° (Espiritu Santo I., Maewo I.) to beyond 20° south latitude (Aneityum I.). These islands show a considerable variety of sizes, aspects and structures — with a volcanic prevalence —. Separated by great depths, they reach sometimes considerable heights (Espiritu Santo I.), and have active volcanoes (Fig. 1).

The climate of the N.H.p. is basically the typical climate of the trade-winds' belt; however, it shows noticeable latitudinal variations. Rainfall is high (3200 mm per year at Luganville, Espiritu Santo I.; 2200 on Aneityum I.). A dry season (May to October) alternates with a wet one, showing seasonal variations which become more marked moving southwards. Larger islands are usually well watered; surface waters, however, may be conditioned by local characteristics, and become scarce during the dry season. Natural vegetation is abundant, and coconuts and subsistence crops are common where there is human influence. On larger islands cattle can be conspicuously present.

Past data on the local mosquito fauna

After an initial entomological note by Laveran (1902) and a short but fundamental investigation reported by Buxton and Hopkins (1927), it has been only considerably later, during and not too long after World War II, that the mosquito fauna of the N.H.p. has been properly studied. These

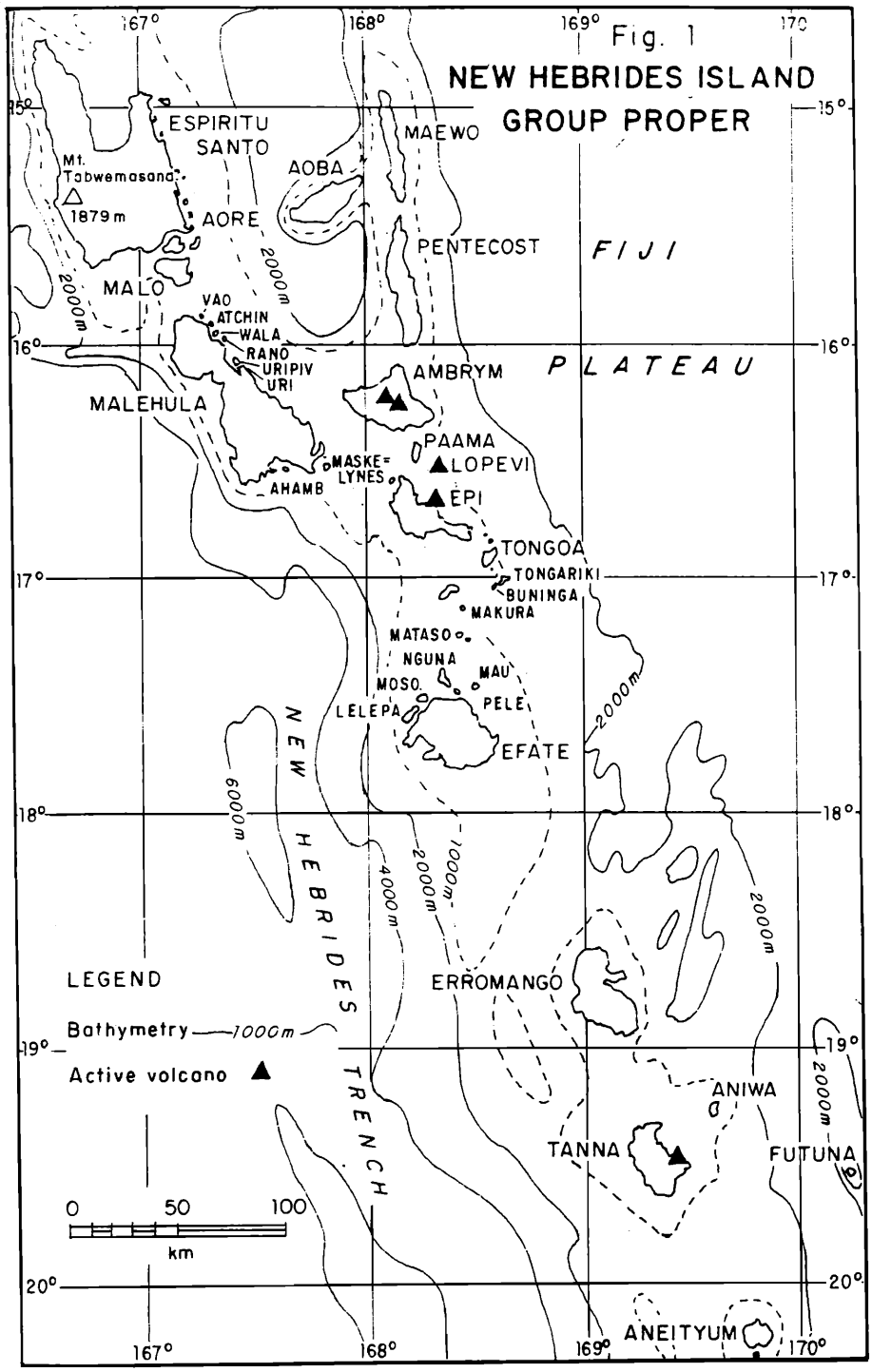
Fig. 1
NEW HEBRIDES ISLAND GROUP PROPER
167°
168°
169°
170
15°
16°
17°
18°
19°
20°
ESPIRITU SANTO
Mt. Tabwemasana
1879 m
AORE
MAEWO
AOBA
PENTECOST
FIJI
MALO
VAO
ATCHIN
WALA
RANO
URIPIV
URI
AMBRYM
PLATEAU
MALEHULA
PAAMA
LOPEVI
MASKELYNES
AHAMB
EPI
TONGOA
TONGARIKI
BUNINGA
MAKURA
MATASO
NGUNA
MAU
MOSO
PELE
LELEPA
EFATE
2000m
6000m
4000m
1000m
NEW HEBRIDES TRENCH
ERROMANGO
ANIWA
TANNA
FUTUNA
ANEITYUM
LEGEND
Bathymetry 1000m
Active volcano
0 50 100
km

activities culminated in the investigations and the capital comprehensive contributions by Rageau and Vervent (1958, 1959) and by Belkin (1962). Since, only a paper by Belkin (1965) and two by Rhodain and Fauran (1975,a,b) have been published. To this material can be added a few documents, mainly internal and relatively recent, which can be found in the files of the Condominium Health Services: they refer to limited and/or casual entomological findings obtained during the field activities of the campaigns against mosquito—borne diseases (malaria, dengue, filariasis) carried out in recent years by the Condominium — and usually sponsored and assisted by the World Health Organization (WHO). I have reported some of these documents, either in the text or references, and quoted them when pertinent.

MATERIALS AND METHODS

With few exception — duly acknowledged — all the specimens listed were found by me, during my visits to the N.H.p. (Jun.-Sept. '71; Jun.-Dec. '75) as WHO (Malaria) short-term consultant. Due to the purpose of these visits, most of the collections were casual, and mainly of aquatic stages (Table 1). No complete individual rearings were possible. The aquatic stages (in MacGregor solution or alcohol) and the imagos (in pill-boxes) were sent to the Bernice P. Bishop Museum, Honolulu, U.S.A., for mounting and pinning. Except for imagos, all specimens have been identified by me. All are deposited in the Bishop.

Each collection is identified by a code number for the date, followed by a serial number for each single collection during that day. E.g., 710702/1..,/2, etc. identify respectively the lst, 2nd, etc. collection made on 2 July 1971. When the date is obvious, only the collection's number is reported. Symbols (♀, ♂, L,l,P,p) are as in Belkin (1962: Fig. 28); generic and subgeneric abbreviations follow Reinert (1975). The results are presented island-by-island, in a logical sequence of localities and/or time.

1971 and 1975 collections from the N.H.p.

ESPIRITU SANTO I. (km² 3,680; pop. 9,800)°. Visited in 1971 and 1975. *Southern coast.* 710705/2: Luganville Town, Public Works Dept., rainwater in discarded truck tyre, *Cx.pacificus*, 4 L, *Ae.hebrideus*, 7 L; /3: Ibidem, Corsica Hotel's courtyard, rainwater in 170-liter drum, *Cx.quinquefasciatus*, 4 L. 750702/1: Mafiuni Village (inland) in scarce rainwater in 170-liter drum, *Cx.pacificus*, 8 L; /2: Ibidem, large open shallow rain collection on muddy soil with small fringe pools, turbid, *Cx.annulirostris*, 15 L, 4 P, *Ae.lineatus*, 8 ♀♀, attacking viciously nearby, at 10 a.m. *Big Bay.* 710901/1: Pialalub Village, in unfinished latrine pit, in shallow rainwater, on concrete, *Ae.hebrideus*, 8 L, 9 P; /2: Ibidem, in shaded nearby forest, in gnawed coconut husk with foul contents, *Tp.melanesiensis*, 10 L; /3; Ibidem, Idem, crater of uprooted tree, in clear rainwater with abundant leaves at bottom, sun-shade, *Cx.femineus*, 1 P, *Cx.buxtoni*, 10 L, *Ae.lineatus*, 9 L; /4: Ibidem, coconut grove, coconut half-husk with foul contents, *Tp.melanesiensis*, 10 L. *Western coast (coastal). Northern part.* 710901/5: Wonpoku Village (near), in slow running waters, at edges of Wonpoku R., sun-shade, in mats of submerged-floating filamentous green algae, *An.farauti*, 2 L, 2 P, *Cx.starckeae*, 6 L, 3 P; *Central part.* 710902/1: Nogugu Village, in small collection of residual spring water, on rocky ground, sunlit, leaves at bottom *An.farauti*, 6 L, *Cx.annulirostris*, 1 L; /2: Tasmate Village, small ground collections near piped water, sun-shade, *An.farauti*, 1 L. *Western coast (inland). Southern part.* 710903/1: Torovuvun Village (100 m a.s.l.), in canals bedded with taro (*Alocasia* sp.), filamentous green algae, sun-shade, *An.farauti*, 12 L, *Cx.annulirostris*, 9 L, *Cx. starckeae*, 6 L; /2: left bank of Keraway R. (150 m), in clear rainwater, sunny, dead leaves at bottom, in rockholes, *Cx.annulirostris*, 2 L; /3 & 4: right bank of Voluelei T. (1000 m a.s.l.), in

rockholes with clear residual rainwater, dead leaves at bottom, sunny, *Cx.femineus,* 19 L, 3 P.
AORE I. (km² 58; pop. 610). Visited in 1975.
750907/1: Ratard Plantation, in large open ground collection of rainwater, with grassy edges, *Cx.annulirostris,* 5 L, *Ae.nocturnus,* 7 L; /2: Seventh Day Adventists' Farm, in open concrete tank for watering cattle, in still, sunlit water with mats of green algae, *Cx.annulirostris,* 3 ♀ ♀ (reared), 1 ♂ (reared), 6 L, 2 l, 4 P, 4 p.
MALO I. (km² 180; pop. 1,800). Visited in 1975.
750908/1: Abwatuntura Village, In treehole, small, clear rainwater collection with organic material at bottom, shaded, *Cx.pacificus,* 6 L, 1 p, *Cx.annulirostris,* 1 ♀ (attacking nearby, at 11 a.m.), *Tp.melanesiensis,* 2 L; /2: Anabataliu Village, near, at end of small creek flowing to the sea, in small, open collection on coral-muddy ground, grassy edges, *An.farauti,* 1 ♂ (reared), 3 L, 1 P.
AOBA I. (km² 400; pop. 6,800). Visited in 1971.
Eastern part. 710706/3: Waimemer Lake, at the edge, in shallow small collection, *Ae.hebrideus,* 1 L; /4: Ibidem, in small groove, with dead leaves, on protruding trunk, *Cx.annulirostris,* 4 L, 3 P; /5: Ibidem, in coconut plantation near shore, in open husk, *Cx.annulirostris,* 1 L, *Ae.hebrideus,* 2 P, *Tp.melanesiensis,* 5 L, 2 P; /6: Ibidem, Idem, *Tp.melanesiensis,* 4 L. 710706/7: on coastal area south of lake, in swamp inland of coastal dune, in temporary grassy ground pools, shaded, deal leaves at bottom, *An.farauti,* 1 P, *Cx.annulirostris,* 1 P, *Ae.nocturnus,* 6 L; /8: Ibidem, in clear rainwater in discarded tin, sand at bottom, shaded, *Cx.pacificus,* 3 L, 5 P, *Ae.hebrideus,* 1 P. 710707/2: Vurias School, coconut spathe in palm grove, *Ae.hebrideus,* 2 L; /3: Ibidem, near Teacher's house, in 170-liter drum, *Cx.pacificus,* 20 L, 3 P, *Cx.quinquefasciatus,* 1 L; /4: Loloway Hospital, quarters of N.H. personnel, resting on walls and mosquito-nets, *An.farauti,* 2 ♀ ♀, *Cx.quinquefasciatus,* 1 ♀, 2 ♂ ♂, *Cx.annulirostris,* 1 ♀. 710708/1: Ibidem, concrete open tank, sunny, deep water, partially polluted, with floating debris, *Cx.annulirostris,* 15 L, 1 P; /2: Loloway beach, in abandoned canoe, in rainwater with leaves at bottom, shade, *Cx.quinquefasciatus,* 2 L, *Ae.hebrideus,* 6 L, 1 P; /4: Ibidem, dried coconut husk with foul contents, *Ae.hebrideus,* 21 L, 6 P, *Tp.melanesiensis,* 1 L; /5/ Ibidem, idem, *Ae.hebrideus,* 6 L; /6: Ibidem, in vertical treehole on stump, clear rainwater, organic bottom, *Ae.hebrideus,* 15 L; /7: Ibidem, small, shallow collections of rainwater on protruding branches of tree *(Inophyllum calophyllum* Linn), shaded, *Cx.pacificus,* 1 L; /8: Ibidem, idem, *Cx.pacificus,* 7 L, 3 P, *Ae.hebrideus,* 1 L, 2 P; /9: Ibidem, in abandoned canoe, leaves at bottom, shade, *Cx.quinquefasciatus,* 2 L, *Cx.sitiens,* 1 L, *Ae.hebrideus,* 7 L. 710709/10: Loloway Village, near pig-stable, rainwater in discarded biscuit metal box, *Ae.hebrideus,* 15 L. 710714/5: Loloway (near), Wailembutaga Lake, in small, footprint-like collections of turbid water, sunny, on peaty soil, *Cx.annulirostris,* 10 L, *Cx.buxtoni,* 2 L, 1 P, 1 ♀, 1 ♂ (both reared).
Southern coast. Western half. 710711/1: Redcliff (=Natarimboe), Seventh Day Adventists' Mission, rainwater in discarded bathtube (to water cattle), sunlit, sediment at bottom, *Cx.annulirostris,* 1 l, 7 P; /2: Ibidem, concrete basin with muddy water and grassy edges, *Cx.annulirostris,* 4 L. 710712/1: Lone Village, coconut shell, *Cx.pacificus,* 2 L.
Northern coast (moving east to west). 710714/1: Lolovangi School (200 m a.s.l.), residual pools, in part on rocks and/or polluted, in small turrent, with dead leaves, shade, *Cx.femineus,* 2 L, 1 P. 710716/1: Ndui Ndui School, in concrete ornamental pond, in still, turbid, sunlit water, *An.farauti,* 6 L, *Cx.annulirostris,* 2 L. 710714/2: Lolopuepue Roman Catholic Mission (near), along dried torrent, in residual pools on rocky bed, *Cx.annulirostris,* 1 L, *Cx.femineus,* 2L; /3: Ibidem, idem, upstream, on gravel and coarse sand, *Cx.pacificus,* 2 L, *Cx.annulirostris,* 1 L, *Cx.femineus,* 5 L, *Ae.lineatus,* 1 L; /4: Ibidem, idem, more mud and dead leaves, *Cx.pacificus,* 1 L, *Cx.annulirostris,* 2 L. 710716/4: Ndui Ndui Village, coconut grove, rat-gnawed coconut with foul contents, *Tp.melanesiensis,* 3 L. 710716/7: Wahala Village, in

° The figure refers only to the mainland: 4,250 are in urban Luganville, 5,550 rural. Malo and Aore Is. (see), and the off-shore islets (km²30; pop. 750) are not included.

canoe stranded on the beach, foul dark rainwater with abundant dead leaves at bottom, *Cx.pacificus*, 2 L, *Cx.annulirostris*, 2 L, *Ae.hebrideus*, 3 ♀ ♀ (resting on wall of canoe), 17 L, 2 P, 1 p. 710716/5: Lakalaka Village, scarce rainwater in 170-liter drum, *Cx.sitiens*, 1 P, *Ae.hebrideus*, 2 L, 1 P; /6: Ibidem, dirty water in half coconut shell, *Ae.hebrideus*, 14 L, 5 P, *Tp.melanesiensis*, 2 L. 710717/1: Vilakalakala French Public School, extensive rainpuddles on road, sunny, *Cx.annulirostris*, 8 L, 1 P; /2: near Copra pier, in damaged canoe, yellowish rainwater, dead leaves, *Cx.sitiens*, 4 L, 4 P, *Cx.annulirostris*, 2 L, 2 P, *Ae.hebrideus*, 5 L, 2 P.
MAEWO I. (= *AURORA I.*). (km² 270; pop. 1,400). Visited in 1971.
Western coast. Central part. 710709/1: Nassawa Village, wheeltrack on soaked meadow, clear sunlit small collections with grassy edges, *An.farauti*, 4 L, 3 P, *Cx.annulirostris*, 5 L, 4 P, *Ae.lineatus*, 3 P; /2: Ibidem, idem, but subturbid and shaded, *Cx.annulirostris*, 3 L, *Ae.lineatus*, 4 L; /3: Ibidem, coconut plantation, rat-gnawed husk with foul contents, *Ae.hebrideus*, 1P 1p, *Tp.melanesiensis*, 13 L.
PENTECOST I. (km² 439; pop. 7,800). Visited in 1971.
Western coast. North to south 710710/1: Abwatuntura Village, in rat-gnawed coconut husk, *Ae.hebrideus*, 1 L; /2: Abwatuntura — Atabulu track, as above, *Ae.hebrideus*, 3 L, 2 P; /4: Loltong — Latano track, as above, *Ae.hebrideus*, 6 L; /5: Ibidem, as above, *Cx.annulirostris*, 7 L, 1 P; /6: on flat meadow just north of Latano Roman Catholic Mission, in ample shallow pools, *An.farauti*, 1 P, *Ae.lineatus*, 8 P; /8: just north of /6, in light coastal wood, in vertical treehole at 150 cm from ground, clear rainwater and organic material at bottom, *Ae.aobae*, 13 L, 1 P, *Ae.hebrideus*, 1 ♀ attacking at 3 p.m.; /7: Latano Mission, step in coconut tree, rainwater, *Ae.hebrideus*, 13 L; /9: near /8, inland, in ample, muddy, sun-shaded open collection, with grassy edges and submerged leaves, *Ae.lineatus*, 3 L, 4 P; /10: Loltong — Labulfamata track, on rocky edge overhanging the sea, in clear rainwater in small rockhole, *Ae.hebrideus*, 5 L, 5 P; /11: north of Loltong, along beach, in half coconut shell, *Ae.hebrideus*, 12 L, 5P. 710722/1: Salap Village, at Baie Homo, in dry coconut husk with foul contents, *Ae.aobae*, 1 L, *Ae.hebrideus*, 2 P, *Tp.melanesiensis*, 2 L, 3 P. 710723/2: Ibidem, in very foul rainwater in discarded cocoa pods, *Cx.pacificus*, 32 L, 1 P, *Ae.hebrideus*, 1 ♂ (reared), 6 L, 2 P, 1 p.
Eastern coast. South. 710723/1: Baie Barrier Roman Catholic Mission, in gnawed coconut with foul contents, *Cx.pacificus*, 1 L, *Ae.hebrideus*, 7 L, 2 P, 1 p, *Tp.melanesiensis*. 1 L.

MALEKULA I. (km² 2,025; pop. 9,050)[1]. Visited 1971 and 1975
Eastern coast. North, 750701/1: Betel Village, rat-gnawed coconut husk, foul contents, *Tp.melanesiensis*, 10 L, 1 P, 3 p; /2: Ibidem, rainwater in discarded tyre. *Cx.pacificus*. 2 L, *Ae.hebrideus*, 1 L, *Ae.pernotatus*, 6 L; /3: Pihalum R., upstream of a concrete road ford, in slow concrete, in slow moving waters with debris, sun-shade, *Cx.annulirostris*, 3 L; /4: Orap Village, at inland edge of beach, in dead branch of estuary, with algae and debris, *An.farauti*, 1 L, *Cx.annulirostris*, 2 L; /5: as /3, upstream, *Ae.lineatus*, 1 ♀, attacking at 11 a.m. in shade; /6: Orap Village, in 170-liter drum, *Ae. hebrideus*, 5 L, 3 P, *Tp.melanesiensis*, 1 L; /7: Seruine R., as in /3, upstream, in ample water collection, slowly flowing, floating leaves, *An.farauti*, 1 L. *Centre*. 750630/1: Hatbol Village, edge of Nurombat R., small collection of residual water, still, half shaded, floating debris, grassy edges, *An.farauti*, 1 L, 1 P; /2: Ibidem, village road, in muddy wheeltracks, grassy edges, sun, *Cx.annulirostris*, 15 L; /3: Ibidem, coconut grove, rat-gnawed husk, *Cx.annulirostris*, 11 L; /4: Bushman Bay Plantation, ditch along road, foul water, vertical vegetation, *Cx.annulirostris*, 4 L, 1 P; /5: Sarmette Plantation (near), along river, in small ground collections of muddy water with grassy, edges, *Cx.annulirostris*, 4 L, 4 p; /6: Ibidem, still waters with grassy edges along dead branch of /5, *An.farauti*, 6 L. *Southern coast*. 750822/18: Farun Village, rat-gnawed husk, clear contents, *Cx.pacificus*, 8 L, *Cx.annulirostris*, 1 L, *Ae.hebrideus*, 6 L. (collect.: Mr. E.Wurvegqeat, N.H. Mal. Serv.). *Western coast. South*. 750823/1: Southwest Bay Hospital, in small, vertical treehole collection in *Ponciana* tree, *Cx.pacificus*, 3 L, *Cx.quinquefasciatus*, 1 L, *Ae.aegypti*, 1 L, *Ae.hebrideus*, 2 L; /2: Ibidem (nearby), small, turbid rainwater collections in wheeltrack, *Ae.nocturnus*, 1 L, 1 P; /3: Ibidem (south of), on meadow with resurgent waters, in small, grassy collections on muddy ground, *An.farauti*, 9 L, *Ae.lineatus*, 2 L, 3 P, *Ae.nocturnus*, 7 L, 1 P. 710914/2: Vinesumbul Village,

main square, in large, shallow rain collection, with grassy edges and submerged leaves, *An.farauti,* 2 L, 2 P, *Cx.annulirostris,* 8 L, 2 l, 7 P. 710914/1, Lawa Village (near, inland), in yellowish rainwater in semi-demolished canoe, *Cx.pacificus,* 4 L, *Ae.hebrideus,* 7 L, 24 P, *Ae.pernotatus,* 1 P; /3: Ibidem, at the limit of the beach, treehole *(Hernandia peltata* Meisen), *Ae.hebrideus,* 4 L, *Ae.pernotatus,* 3 L, 2 P; /4 : Ibidem, on beach escarpment, in rainwater, sunlit, in abandoned canoe, *Ae.hebrideus,* 3 L, 5 P, *Ae.pernotatus,* 3 L, 1 P; /5: Ibidem, in coastal forest, in shaded rainwater in 2 abandoned canoes, *Ae.hebrideus,* 15 L, 12 P, *Ae.pernotatus,* 4 L, 2 P; /6; Ibidem, in forest, in abandoned 170-liter drum, full of rusty rainwater, *Cx.pacificus,* 1 L; /7: attacking indoors at 10 p.m., *An.farauti,* 1 ♀. *Centre.* 750823/4: Vunmavis Village, along sea-shore, in pits on pre-tidal coral basement fed by low-tide seeping freshwater added to seawater, with algae and debris, *An.farauti,* 19 L, 7 P, *Cx.annulirostris,* 6 L. 710911/1: Lassemu Bay, inland, forested, in treehole of *Laportea* sp., clear rainwater, dead leaves at bottom, *Cx.pacificus,* 4 L, 1 l, 2 P, *Tp.melanesiensis,* 5 L, 1 l, 11 P.*North.* 750824/0: Brenwei R., at estuary, at grassy edges, in almost still water, sunlit, with floating materials, *An.farauti,* 3 L. 710911/2: Honfar R., at estuary, in stagnant water, vertical grass, sun-shade, dead leaves and debris, *An.farauti,* 1 ♀ (reared), 3 ♂♂ (reared), 28 L, 4 P, 4 p, *Cx.annulirostris,* 1 L. 710911/3: Brenwei Village, rainwater in coconut spathe, *Ae.hebrideus,* 4 L, 8 P; 710912/2: Ibidem, in vertical treehole with organic material at bottom, *Ae.hebrideus,* 8 L, 20 P, *Ae.pernotatus,* 2 L, 1 P; /3: Ibidem, in small collection among roots of «*kalaka*» tree, *Ae.hebrideus,* 23 L, 7 P; /4: Ibidem in big, cylindrical rainwater collection in stump of «*ndukh*» tree, with organic material, *Tp.melanesiensis,* 4 L. 750824/1: Ibidem, Idem, *Cx.pacificus,* 2 L, 1 p, *Tp.melanesiensis,* 12 L, 7 P. 710912/5: Brenwei (near), along reef's inner limit, in pits on coral/limestone, in brackish water, shaded, *Cx.sitiens,* 18 L; /6: Ibidem, Idem, sunny, slightly brackish, *Ae.hebrideus,* 2 L, 2 P; /7: Ibidem, Idem, small pits, with *Casuarina* leaves at bottom, *Ae.hebrideus,* 10 L, 33 P, 2 p; /8: Ibidem, idem, fresh rainwater on coral pit, *Cx.sitiens,* 1 L, *Ae.hebrideus,* 22 L, 12 P; /9: Ibidem, idem, ample collection, at the end of a gully, with *Casuarina* leaves, *Cx.sitiens,* 9 L, 16 P. 750824/2: Tontar Village, 170-liter drum, clear rainwater, *Ae.nocturnus,* 4 L, *Ae.hebrideus,* 10 L, 13 P.

ISLETS OFF MALEKULA I. (km² 16; pop. 3,860). Visited in 1975.

Islets located off-shore the northern half of the eastern coast of Malekula I. : *Vao I.* 750825/1: Noroure Village (inland of), in coral-dug well, clear, deep, fresh, natural water, vertical vegetation at edges and mats of algae, sunlit, *An.farauti,* 4 L, *Cx.annulirostris,* 3 L; /2: Betheul Village (sea-shore), in big, cylindrical, open-mouthed, stone-walled well, with shallow, sea-fed water table, sunlit, debris at bottom, *An.farauti,* 3 L.

Atchin I. 750819/1: Roman Catholic Mission Village, from several 170-liter drums, *Ae.hebrideus,* 1 ♀ (reared), 2 L, *Tp.melanesiensis,* 1 ♀ (reared), 1 P, 2 p. *Wala I.* 750819/2: Wala Village, from several 170-liter drums, clear rainwater, *Cx.pacificus,* 2 L, *Tp.melanesiensis,* 1 L; /3:Ibidem, idem, *Ae.hebrideus,* 1 ♀ (reared), *Tp.melanesiensis,* 2 L, 1 P.

Rano I. 750901/1: i) Melerir and Patora Villages, in deep wells for drinking, in clear, cool and shaded waters, *An.farauti,* 2 L, 2 P, 1 p; ii) Janabon, Sosi, Waron, Bethelem and Melino Villages, from several 170-liter drums, *Cx.femineus,* 1 L, *Ae.hebrideus,* 1 L (specimens collected by:Mr. Oted Samson, Health Services, Norsup). *Uripiv I.* 750818/5: Botum Village, from several 170-liter drums, rainwater, clear, *Cx.pacificus,* 1 L, *Cx.quinquefasciatus,* 7 L, *Ae.hebrideus,* 2 L, *Tp.melanesiensis,* 3P; /6: Cinepu locality (inland), clear water in small stone-walled well, *Cx.femineus,* 4 L; :7: Ibidem, slightly more inland of /6, resting on walls of a bigger stone-walled well, at 12 a.m., shade-sun, *Ae.hebrideus,* 1 ♀, *Tp.melanesiensis,* 1 ♀. *Uri I.* 750818/1: Uri Village (near to), in subturbid, shaded water, debris, in small shallow, superficial coral-dug well, semi-abandoned, *Cx.pacificus,* 2 L, *Cx.annulirostris,* 2 ♀ ♀ (reared), 8 L, 2 p; /2: Ibidem, approx. 100 m inland, as above but smaller and dirtier, *Ae.hebrideus,* 2 ♂♂ (resting); /3: Ibidem, 300 m inland of /2, limited water, fully shaded, in small,

[1] Only mainland. Islets reported separately (see).

irregularly shaped well, *Ae.hebrideus*, 1 ♀ attacking nearby at 10 a.m. : /4: Ibidem, 200 m inland of /3, at very limited water, fully shaded, in underground collection, pocket-shaped, *Cx.femineus*, 1 ♀ (captured on the author's sleeve), 2 ♂ ♂ (resting underground).
Located southeast and south off Malekula mainland:
Kulivu I. (Maskelynes Is.). 750822/1: Lutes Village, small ground well, with subpolluted water, vertical and recumbent vegetation, sun-shade, *An.farauti*, 1 ♀ (reared), 1 ♂ (reared), 7 L, 1 l, 1 p; /4: Ibidem, abandoned canoe, rainwater with abundant dead leaves at bottom, *Cx.quinquefasciatus*, 7 L, 2 P; /5: Ibidem, rainwater in rusty biscuit tin, *Ae.hebrideus*, 4 L. 750822/2: Mitoch locality (just south of Lutes), treehole, small, organic material at bottom, *Cx.pacificus*, 3 L, *Cx.quinquefasciatus*, 1 L, *Ae.hebrideus*, 1 L; /3: shallow depression on muddy soil, 100 m from sea, small collections of muddy water, *An.farauti*, 1 L, 1 P, *Ae.lineatus*, 4 L, 3 P, *Ae.nocturnus*, 1 L. 750822/6: Pellonk Village, rainwater catching basin in concrete, shallow residual water, with dead leaves, *Cx.sitiens*, 8 L, 6 P; /7: Ibidem, shallow rainwater collection on muddy soil, 100 m from seashore, *Cx.sitiens*, 2 L, 4 P. *Ahamb I.* 750822/8: Torok Village, 170-liter drum, *Cx.pacificus*, 7 L; /9: Ambanor Village (near), ground-dug well, clear water, floating debris, *An.farauti*, 1 P; /10: Ibidem, other similar well, *Cx.femineus*, 10 L, 4 P; /11: Ambanor — Lambuerar path, rat-gnawed coconut husk, *Ae.hebrideus*, 6 L; /12: Marirau Village (near), in small, vertical treehole collection, *Ae.pernotatus*, 2 L; /13 / Ibidem, rainwater in half coconut husk, *Ae.hebrideus*, 4 L; /14: Laburubraur Village, rainwater in 170-liter drum, *Ae.hebrideus*, 9 L, 2 P; /15: Ibidem, rat-gnawed husk, *Ae.hebrideus* 3 L, *Ae.pernotatus*, 4 L; /16: Ibidem, clear rainwater in 170-liter drum, *Cx.pacificus*, 6 L, *Ae.hebrideus*, 6 L; /17: Penbamul Village, cattle-watering hole on muddy soil, shaded, *Cx.sitiens*, 3 P, *Ae.nocturnus*, 5 L.
AMBRYM I. (Km^2 665; pop. 4,900). Visited in 1971.
Northern coast. 710723/3: Roman Catholic Mission, Olal, canoe on beach, yellowish rainwater, dead leaves at bottom, *Cx.pacificus*, 8 L, 1 P, *Cx.sitiens*, 1 L; /4: Fona Village, at sea shore, rock pool, sunny, rainwater (brackish?), submerged leaves, *Cx.sitiens*, 9 L, *Ae.hebrideus*, 2 ♀ ♀ (reared), 1 L, 10 P, 1 p, *Ae.pernotatus*, 1 P. 710724/1: Ibidem (above, at 100 m a.s.l.), shallow, sunny, treehole collection, with dead leaves at bottom, *Cx.pacificus*, 1 ♀ (damaged), 2 L, 1 P, *Tp.melanesiensis*, 2 L. /2: Roman Catholic Mission, Olal (west of), on rocky bed of torrent in a gully, sunny, rainwater in rock pools, *Cx.pacificus*, 14 L, *Ae.hebrideus*, 1 L, 1 P; /4: Ibidem, upstream, similar breeding places, *Cx.pacificus*, 15 L, 14 P, *Ae.hebrideus*, 1 P, *Cx.femineus*, 2 ♂ ♂ (resting on shaded, wet rocks): /5; Ibidem, upstream, amongst rocks, residual pools on sandy-muddy bottom, submerged ferns, *Cx.pacificus*, 3 L, 6 P, *Cx.femineus*, 1 L; /6: Ibidem, farther inland, as above but clear water, *Cx.pacificus*, 4 L, 1 P, *Cx.femineus*, 6 L. /7: Metanwar Village (40 m a.s.l.), clear rainwater in 170-liter drum, *Ae.hebrideus*, 5 L; /8: Ibidem, abandoned canoe, dark yellowish rainwater, leaves at bottom, *Cx.pacificus*, 9 L, *Ae.hebrideus*, 1 P; /9: Ibidem, cilindrical treehole (in «*hira*»), with clear rainwater and organic material at bottom, *Cx.pacificus*, 5 L, *Tp.melanesiensis*, 4 l, 4 p. /10: Seventh Day Adventists' Mission, Linboul Village, in steep gully, in rainwater and residual waters in rockholes, *Cx.femineus*, 13 L, 6 P.
Southern coast. 710726/1: Baiap Village, ground water tank in concrete, residual, shallow water, sun-shade, *Ae.hebrideus*, 2 L; /2: Ibidem (near to sea), coconut grove, in shallow rainpan on muddy soil, with grassy edges, sun-shade, *An.farauti*, 6 L; /3: Ibidem, same grove, into 170-liter drum, without bottom, dug into the soil at sea level, containing water, some floating material, *Cx.pacificus*, 3 L, *Cx.annulirostris*, 3 L.
PAAMA I. (km^2 33; pop. 2,240). Visited in 1971.
Western coast. 710727/4/ Tevie Village (north), clear rainwater in 170-liter drum, some organic material at bottom, *Cx.pacificus*, 1 L, *Ae.aegypti*, 2 L. 710728/1: Liro Village (centre), Presbyterian Mission, concrete ditch, clear rainwater, floating debris, leaves at bottom, *Cx.pacificus*, 6 L, 4 P; /2: Ibidem, treehole on *Artocarpus* sp., clear rainwater, organic material at bottom, *Cx.pacificus*, 6 L, *Tp.melanesiensis*, 3 L. 710727/1: Tavaluai Village (south), beach, rat-gnawed husk, *Cx.pacifus*, 2 L; /2: Ibidem, abandoned canoe on beach, yellowish rainwa-

ter, leaves, *Cx.pacificus*, 4 L, *Ae.hebrideus*, 2 L; /3: Ibidem, rat-gnawed coconut husk, *Cx.pacificus*, 7 L, *Ae.hebrideus*, 2 P.
Eastern coast. Centre. 710728/3: Lulep Village, clear rainwater in 170-liter drum, *Cx.pacificus*, 1 L, *Ae. hebrideus*, 1 L; /4: Ibidem, canoe on beach, dark yellow foul rainwater, *Cx.pacificus*, 1 L, *Cx.sitiens*, 2 L, *Ae.hebrideus*, 3 L, 1 P.
EPI I. (km² 444; pop. 1,980). Visited in 1971.

Northern part. Tip. 710728/5: Lamaron Bay — Paia road, in coastal woods, shaded, *Ae.lineatus*, 2 ♀ ♀, attacking viciously at 2 p.m. *Northeastern coast.*, 710728/6: Moriou Village, rat-gnawed husk with foul contents, *Cx.pacificus*, 7 L, 3 P; 710729/2: Nikaura Village, clear rainwater in 170-liter drum, *Ae.hebrideus*, 1 L; /3: Ibidem, treehole in *Hernandia peltata* Meisen, cilindrical, clear rainwater, organic material at bottom, *Ae.hebrideus*, 7 L, *Ae.pernotatus*, 3 L, *Tp.melanesiensis*, 17 L. *Northwestern coast.* 710729/4: Laman Bay, British School, sunlit estuary of river blocked by sandbar, grassy edges and floating debris, *An.farauti*, 2 L, *Ur.barnesi*, 1 L, *Cx.annulirostris*, 2 L. 710730/1: Bonkovia Village, near beach, rainwater amongst tree roots, *Ae.hebrideus*, 13 L; /2: Ibidem, idem, as above in different tree, *Ae.hebrideus*, 1 L, *Ae.pernotatus*, 3 L; /4: Ibidem, near houses, scarce rainwater in 170-liter drum, *Cx.pacificus*, 1 L, 2 P, 2 p; /5: Ibidem, in coastal forest, clear rainwater in discarded paint pail, shade, *Ae.pernotatus*, 1 L, *Tp.melanesiensis*, 11 L.
Laman I. 710729/1: Presbyterian Mission (near), in light forest, discarded stone-walled well, clear water, some vertical vegetation, sun-shade, *An.farauti*, 3 L, *Cx.femineus*, 1 L (collect.: Mr.P.E.A.Lietaert, Technical Officer, W.H.O.).
EMAE I. (km² 32; pop. 630). Visited in 1971 and 1975.
Southeastern part. 710731/1: near Dispensary, rat-gnawed husk with foul contents, *Ae.hebrideus*, 2 L, 1 P, *Tp.melanesiensis*, 1 P; /2: Ibidem, clear rainwater in 170-liter drum, *Cx.pacificus*, 1 L, *Ae.hebrideus*, 3 L. *Northwestern part.* 710731/3: Sulna Village, in flooded coconut plantation, shallow residual rainwater on coral soil, grassy, sunny, *Ae.lineatus*, 5 L, 5 P, *Ae.nocturnus*, 4 L. 750706/1: along coastal path, in light forest, *Ae.lineatus*, 9 ♀ ♀, attacking viciously at 10 a.m.; /2: Ibidem, in forest fringing the beach, in coconut husk with foul contents, *Ae.hebrideus*, 3 L, 1 l; /3: Ibidem, in vertical treehole, with organic material at bottom, *Cx.pacificus*, 3 L, *Ae.hebrideus*, 1 ♀ (reared), 1 p, *Ae.pernotatus*, 2 L.
MAKURA I. (km² 1; pop.190). Visited in 1975.
750705/2 & 3: Malakola Village, rainwater, clear, in various 170-liter drums, *Ae.aegypti*, 14 L, *Ae.hebrideus*, 2 L.
MATASO I. (km² 1; pop. 160). Visited in 1975.
750705/1: Nasanga Village, in abandoned village well, stone-walled, with cool, shaded water, floating debris, *An.farauti*, 1 ♀ (reared), 7 L, 2 p, *Cx.annulirostris*, 1 ♀ (reared), 4 L, 1 p.
EFATE I. (km² 915; pop. 13,750)[1]. Visited on 1971 and 1975.
Southern coast. West. 750726/1: Pangano Swamps, at fringe, open, sunlit collections of still water on muddy-peaty soil, floating debris, submerged materials, algae, waterlilies, *Cx.annulirostris*, 11 L, 2 P. /2: Devil's Point, Tukutuku Plantation, minimal residual collections in hoofprints on muddy soil, *Cx.annulirostris*, 1 ♀ (reared), 2 ♂ ♂ (reared), 4 L, 11, 2p; /3: Ibidem, upstream Tukutuku Torrent from concrete road ford, in slowly flowing water, shaded, with floating debris and algae, *An.farauti*, 9 L, *Cx.starckeae*, 2 ♀ ♀ (reared), 2 ♂ ♂ (reared), 2 L, 1 P, 6 p; /4: Jeffrey's Chicken Farm (near), in small collections of seeping water, grassy, *An.farauti*, 17 L, 1 l. /5: Mele River, upstream of estuary, amongst reeds, at the edge, *Cx.annulirostris*, 3 L. 750810/1: Mele School, school's grounds, rainwater shallow wide collection on grass, algae mats, floating, *Ae.nocturnus*, 2 ♀ ♀ (reared), 2 L, 5 p. /2: *Mele Island.* On *Ponciana*, treehole, with abundant organic material, *Cx.pacificus*, 2 ♀ ♀ (reared), 2 L, 3 P,

[1] Strictly mainland, resulting from 9,250 urban (Port-Vila) and 4,500 rural. The off-shore islets, not included, will follow.

3 p, *Ae.aegypti*, 1 ♂ (reared), 1 L, *Ae.pernotatus*, 3 ♂ ♂ (reared), 1 P, 2 p. *Inland road.* 750917/2: Maat Village, along river, in residual collections, still waters, vertical vegetation, mats of algae, *Cx.annulirostris*, 5 L; 750918/2: Ibidem, in man-made collection, still, foul water, abundants mats of algae, *Cx.annulirostris*, 4 L, *Cx.starckeae*, 2 ♀ ♀ (reared), 1 ♂ (reared), 4 p. 750917/1: Emile Mahé Village (100 m a.s.l.), in swampy area with taro, ditches with *pistia* and floating vegetation, *Cx.annulirostris*, 8 L. 750918/1: Snake Hill Village, rainwater in discarded tyre, *Cx.pacificus*, 4 L. *East.* 750812/1: Vila-Pango road, locality Epangtuei, near beach, discarded stone-walled well, fresh water in shade, floating debris, *Cx.annulirostris*, 6 L, *Cx.buxtoni* (?), 1 L, 2 P. /2: Pango Village, British School, almost foul water in 170-liter drum, *Cx.pacificus*, 3 L; /3: Ibidem, in garden, foul water, with sticks and leaves, at bottom of broken bottle, sunlit, *Ae.hebrideus*, 5 L. *Northern coast. West.* 750704/1: Point Bluff (facing Moso I.) at beach's fringe, in small rainwater in groove on a protruding branch with leaves at bottom, *Cx.pacificus*, 1 L, *Ae.hebrideus*, 3 L, *Ae.pernotatus*, 5 L. *East.* 710823/1: Panangisu Village, shallow dirty water in cilindrical concrete container. *Cx.quinquefasciatus*, 3 L; /4: Ibidem, clear rainwater in 170-liter drum, *Ae.aegypti*, 6 L. /2: inland of Panangisu, at the sources of the Lukunmaewa R., in small rockholes with dead leaves at bottom, *Cx.femineus*, 16 L; /3; Ibidem, idem, but bigger, on rocky bed of river, *Cx.femineus*, 9 L. /5: Panangisu (near), retrodunal bush, lightly wooded, in open, sunlit ground collection, floating algae, *Cx.annulirostris*, 1 ♂ (reared), 9 L, 1 p; /6: Ibidem, idem, but more muddy, shaded, *Cx.annulirostris*, 3 ♀ ♀ (reared), 2 ♂ ♂ (reared), 4 L, 1 P, 5 p.

ISLETS OFF EFATE I. (km^2 71; pop. 2,800). Visited in 1971 and 1975.

Mao I. 710922/1: Lashake Village (coastal), clear water in 170-liter drum, *Ae.hebrideus*, 5 L. /2: Waina Village (inland of), in pig-pen lightly wooded, in small collections of muddy water on ground, sun-shade, *Cx.pacificus*, 2 L, *Cx.annulirostris*, 2 L.

Nguna I. 751008/1: Warialapa Village, boulders near beach, rainwater collections in rockholes, with dead leaves, *Cx.sitiens*, 3 L; /2: Ibidem, idem, *Cx.pacificus*, 1 L, *Ae.hebrideus*, 2 L; /3: Ibidem, but above village, in open stone-walled wellpond, turbid water, vertical vegetation, *Cx.annulirostris*, 5 L, 1 l, 1 P. /4: Warialapa — Niwaba path, among boulders overhanging beach, ample collection, with debris, *Cx.annulirostris*, 3 L. /5: Malaliu Village (170 m a.s.l.), in village pond for washing (similar to /3), *Cx.sitiens*, 1 L, 1 l, *Cx.annulirostris*, 2 L; /6: Tigeilassu Village (near) (at 15 m a.s.l.), on boulder, small rockholes with thick leaves at bottom, *Tp.melanesiensis*, 2 ♂ ♂ (reared), 20 L, 8 P, 2 p; /7: Ibidem, at village, on rocky ground, seeping collection, turbid, sunlit, *Cx.pacificus*, 3 L, *Cx.annulirostris*, 3 ♀ ♀ (reared), 5 ♂ ♂ (reared), 1 L, 2 l, 2 P, 11 p.

ERROMANGO I. (km^2 975; pop. 700). Visited in 1975.

Western coast. Centre. 750923/1: Potnan Polpar locality (2 km upstream William R. from Dillon's Bay). Residual water collections amongst rocks of left bank, floating and submerged material, sun-shade, *Cx.annulirostris*, 9 L. 750924/1: Nunapon Farm (Rouleau's), near ducks'farm, small water collections on muddy soil with taro, shade (180 m a.s.l.), *Cx.annulirostris*, 4 L. 750925/1: Tunbu River, inland (170 m a.s.l.) on basaltic rocks, in small, sunlit rainwater collections with muddy bottom, *Cx.annulirostris*, 4 L.

TANNA I. (km^2 550; pop. 12,050). Visited in 1975.

Western coast. 750804/1: Isangel Centre (above, at 120 m a.s.l.), in plantation, in husk with foul contents, *Cx.quinquefasciatus*, 6 L. /2: Leneai Village (150 m), scarce rusty rainwater in 170-liter drum, *Ae.hebrideus*, 11 L, *Cx.quinquefasciatus* (?), 1 p. 750805/1: Lenemi locality, at estuary of Lesdemud R., on river bed, coconut half husk, *Tp.melanesiensis*, 1 ♀ (reared), 1 ♂ (reared), 51 L, 7 P, 5 p. /2: along Isangel — Lenakel road, near Lenakel School, at northern part of Lenakel harbour, ample collections of rainwater and seeping water on rocky ground, grassy edges and mats of green algae, *An.farauti*, 1 ♀ (reared), 16 L, 1 P, 1 p, *Cx.annulirostris*, 1 ♀ (reared), 3 ♂ ♂ (reared), 19 L, 1 P, 4 p; /3: Lenakel R. Paul's Shop (north of), on coral reef, in rivulets of seeping fresh water, grassy, edges, floating debris, green algae, *An.farauti*, 1 L.

Eastern coast. 750926/1: White Sands Village, on beach, in rainwater in canoe, *Cx.quinque-*

fasciatus, 3 L; /2: Ibidem, idem, in coconut husk, *Ae.hebrideus*, 7 L. 750926/8: Port Resolution Village, in ample ground-dug well, stone-walled, sun-shade, debris, *Cx.femineus*, 1 p; /9: Ibidem, garden, in rat-gnawed husk, *Ae.hebrideus*, 4 L, 3 P, 4 p. *Inland.* 750926/3: Yenemahu Village (100 m a.s.l.), along steep, shaded gully, in small basin, hewn in tufa wall, to collect clear water, *Cx.femineus*, 3 L; /4: Ibidem, idem, near main water spring, in small collections in fern stumps of palisade, *Tp.melanesiensis*, 14 L, 5 P; /5, Ibidem, near village, in coconut husk, *Cx.pacificus*, 5 L, 2 P. 750926/6: Nabontahua Village (150 m), clear water in 170-liter drum, *Tp.melanesiensis* 3 L; /7 & 7 bis: Ibidem (nearby), in coconut grove, in treehole on stump, at ground level, clear water, *Cx.pacificus*, 9 L, *Ae.hebrideus*, 1 L, *Tp.melanesiensis*, 9 L, 2 p.

ANIWA I. (km² 20; pop. 260). Visited in 1975.

750806/1: French School (near), man-dug pool, abandoned, foul, with floating debris, and submerged branches, *Cx.annulirostris*, 2 L. /2: Itangutu Village (near), man-made spacious washing pool, sunny, with grassy edges, *Cx.annulirostris*, 5 L. /4: Tacumu locality, lightly wooded coastal area, with shallow, sunlit, brackish rivulets, slow moving, on rocky and graveled bottom, *Cx.sitiens*, 35 L, 10 P, *Ae.vigilax*, 3 ♀ ♀ (attaching at 10 a.m.), 3 L, 3 P, *Ae.hebrideus*, 2 ♀ ♀ (attacking at 10 a.m.); /5, Numalaku locality (200 m from /4), water basin of 3 m radius, natural, open, brackish, against big boulder, *Cx.annulirostris*, 3 P, *Ae.vigilax*, 2 L. /6: Imale Village (north of), along gully on coral limestone, shade, in small collection, clear, amongst rocks, *Cx.annulirostris*, 15 L. /7: Ikaukau Village, in:i) washing pool; ii) natural, open rainwater collection with grassy edges; iii) spacious rainwater collection in light forest, shaded, with leaves at bottom: *Cx.annulirostris*, 10 L (total); /8: Ibidem, in village, man-made basin for washing, abandoned, full of sticks, with foul water, *Cx.annulirostrix*, 8 L.

ANEITYUM I. (km² 145; pop. 370). Visited in 1975.

Southern half. Coastal. 751113/1: Anliholo Village (near to), taro gardens, polluted, still water, sunny, in narrow ditch, *Cx.annulirostris*, 9 L, 8 p; 751119/1: Ibidem, idem, *Cx.annulirostris*, 1 L, 1 P. 751116/1: Analgahaut — Liolger R. path, in coconut grove, in rat-gnawed husk, *Cx.quinquefasciatus*, 3 L, *Ae.hebrideus*, 7 ♀ ♀ (reared), 1 ♂ (reared), 3 L, 5 p, *Ae.pernotatus*, 2 L, *Tp.melanesiensis*, 2 L, 2 P. /2: Nerianisinegen Promotory in coastal forest in man-cut small square groove on root of *Barringtonia* sp. tree, yellowish water, leaves at bottom, *Ae.pernotatus*, 14 L; 751119/7, bis & 7 tris: Ibidem, idem, *Ae.hebrideus*, 2 ♀ ♀ (attacking at 9 a.m.), 9 ♂ ♂ (resting), *Ae.pernotatus* 1 ♀ (resting), 5 ♂ ♂ (reared), 41 L, 1 l, 5 p. 751116/3: Unibeletep locality (near to), coastal forest, near abandoned stone-walled well, foul rainwater with debris, *Ae.hebrideus*, 2 ♀ ♀ (attacking at 4 p.m.), 4 ♂ ♂ (resting). 751119/4: Analgahaut Village, near pig-pen, in *Tridacna* hell with muddy water, *Ae.hebrideus*, 3 L; /5: Ibidem, similar, near to beach, clear water and leaves at bottom, *Ae.hebrideus*, 5 ♀ ♀ (reared), 6 L, 4 p, *Ae.pernotatus*, 1 ♀ (reared), 1 L, 1 p. 751119/2: Analgahaut Village (north of, inland), at fringe of big swamp, in grassy edges of small canals and in limited collections of still water, among grass, ferns and reeds, *Cx.annulirostris*, 5 L.

Early instar larvae of *An.farauti* were seen — but not collected — in taro bedded canals at the base of the Nerianisinegen Promontory. This is why I give *An.farauti* as seen by me on Aneityum I.

Notes on the 1971 and 1975 collections, by species.

Anopheles (Cellia) farauti Laveran 1902.

The sole anopheline present in the N.H.p., *An.farauti* is the known local vector of malaria and the main, and possibly only vector of human periodic filariasis.

When added to those reported in the past, my findings show that this species is widespread over the N.H.p.: indeed, in spite of the dry season — a known limiting factor for the easy finding of *An.farauti* (Buxton & Hopkins, 1927:67-68) —, I could add the insular records for the islands of Maewo, Pentecoste, Epi, Mataso, Rano and Kulivu (the last in the Maskelynes Is.) and Ahamb. Amongst the islands that I have been able to visit fairly thoroughly, it has been actually only on Paama that I could not find *An.farauti*. In altitude, my record has been at

approx. 100 m, on Espiritu Santo I. (710903/1): considerably below the 366 m, where, on Espiritu Santo I., Laird had found this species (1955:276)".

The location of its breeding sites — permanent and/or temporary — is very important in the case of *An.farauti*, a major vector of diseases. Long ago, Buxton was the first to guess and to report the peculiarities, in the N.H.p., of the breeding of this species (1926:434-435). Shortly later, he elaborated on this matter, having fully realized the importance of the local prevailing geological features, detected and listed actual and possible breeding sites, and made pertinent suggestions on species control (Buxton & Hopkins, 1927: 69-72). Considerable time later, during and after World War II, this subject was taken up again and extensive investigations lead to confirm and extend the wide range of adaptability of *An.farauti* to the prevailing local ecology, often unsuitable to this species, and the considerable variety of its breeding sites (see: Rageau & Vervent, 1959:2.9-14). My experience confirms these past reports on the permanent breeding sites of *An.farauti:* my collections are all from ground waters. If I never found *An.farauti* breeding in artificial containers — an event admittedly possible but uncommon — it is probably because of the dry season of my collecting.

In the campaign which at present is carried out in the New Hebrides Condominium against malaria, vector source reduction is one of the measures enforced. For its correct and successful implementation it is imperative to know about the actual and possible breeding sites of *An.farauti*, particularly the permanent ones. In the past, swamps, taro fields and stagnant pools have been considered more important breeding sites than water holes dug near the villages and/or sea-shore seeping water pools (Buxton, 1926:436; Buxton & Hopkins, 1927:71-72; Rageau & Vervent, 1959:21-22). From a recent assessment I have made, however, it appears that at present the two last categories of permanent breeding sites have become the most important (Maffi, 1976:3-4,9). For the village dug water holes (for drinking, cooking and/or washing) this change may have been the result of the growing habit amongst the villagers of collecting and keeping for such necessities the rainwater in personal containers — usually 170-liter drums — kept just outside their homes: this has resulted in the total or partial abandon and neglect of the traditional village wells, which consequently have become more suitable breeding sites for *An.farauti* (and other mosquitoes). Something similar has happened to the sea-shore pools of seeping water — a typical breeding site for *An.farauti*, particularly on some islands, as noted by Buxton long ago (1926:434-435).

Simple and unexpensive steps — e.g.: the provision of a cover to the village wells, and to limit and suitably arrange (by cleaning and covering them) the sea-shore pools — could well pay excellent dividends in vector source reduction, and consequently in malaria (and filariasis) control. The resulting provision to the villages of more and unpolluted water would also reduce the number of drums, thus limiting the present breeding facilities for nuisance mosquitoes, and, in particular, for *Ae.(Stg.)aegypti*, the local vector of dengue fevers.

Mataso I. is a typical exemple of *An.farauti* breeding in the only existing sites on the island: discarded wells. The island could easily be made vector-free.

The specimens of *An.farauti* I have collected in the N.H.p. show in general the morphological characters described in the past literature (Buxton & Hopkins, 1927:72-74; Rageau & Vervent, 1959:4-9; Belkin, 1962:139-140). The larvae of my collections show a prevalence of inner clypeals (2-C) simple or gently frayed. Amongst the limited number of adults available, 4 specimens (1 ♀, 3 ♂♂) from Malekula I. (710911/2) show *An.(Cel) koliensis* wings, i.e. without a separate sectorial dark spot on vein C between basal and median dark spots.

Uranotaenia barnesi Belkin 1953

" On Gaua I., in the Banks — i.e. outside the N.H.p. but in the same faunal subarea — Daggy had already reported the presence of *An.farauti* at 366 m (1945:1).

A single finding of a single larva (Epi I., 710729/4) adds little to what is known, or still has to be known about this species in the N.H.p. (Belkin, 1962:172-174).

Culex (Culex) pacificus Edwards 1916

Except for its presence on Merelava I., in the Banks (Maffi & Taylor, 1977: 513,517,520), *Cx.pacificus* is a species strictly limited to the N.H.p. My additional records show that *Cx.pacificus* is considerably more widespread than had been formerly reported; and I believe that a careful search — a necessity when treehole-breeders are looked for — will show a even larger distribution of the species in the N.H.p. Found on Aoba, at approx. 1,200 m height (Crater Lake), *Cx.pacificus* shares with the other species also found there *(Cx.(Lop)* Aoba form, *Ae.(Ver)lineatus, Ae.(Stg)aobae* and *Tp.(Rah) melanesiensis)* the altitudinal record in the N.H.p. (Belkin, 1965:15), *Cx.pacificus* females do not attack man (Belkin, 1962:192) : their capture is therefore very incommon.

My findings confirm the reported preferences of *Cx.pacificus* for treeholes, with a fairly frequent breeding in other containers, natural or artificial (coconut husks, cocoa pods, canoes, 170-liter rainwater drums, tins, discarded truck tyres). Occasionally — as already reported (Buxton & Hopkins, 1927:87; Rageau & Vervent, 1958:21) — *Cx.pacificus* can breed also : in residual pools on drying torrents (Aoba I., 710714/3; Ambrym I., 710724/5), in rock pools (Ambrym I., 710724/2), in rockholes (Nguna I., 751008/2), in seepage waters on rocks (Nguna I., 751008/7), in small abandoned wells (Uri I., 750818/1), in small pools on clay soil, in pig-pen (Mao I., 710922/2). In these cases various ground water-breeding species will be associated.

In general, the morphological characters of the specimens of *Cx.pacificus* I have collected fully back the statement that it is easy to differentiate *Cx.pacificus* from the other members of the subgenus (Belkin, 1962:192). A few specimens, however, show minor variations, two in particular: a double-branched 3-P in the larva (usually limited to one side); a single 3-II, III in the pupa. The latter character — also shown in Buxton & Hopkins (1927:fig.17.E) — is worth reporting: knowing it, when using Belkin's key to the species of subgenus *Culex* (1962:187) it will be easy to avoid ending into the *atriceps* group. I have also noticed that of the 2 *Cx.pacificus* collections on Tanna I. — southern limit of the species —, one is as usual, whilst in the other the apical spine(s) of the comb scales of the larvae are strikingly prominent and large, and the trumpets of the pupae are considerably expanded at the apex (750926/5).

Morphological and other differences between *Cx.pacificus* and *Cx. (Cux) banksensis* — a species limited to some of the Banks islands, and never yet found sympatric with *Cx.pacificus* — have been presented elsewhere (Maffi & Tenorio, 1977).

Culex (Culex) australicus Dobrotworsky & Drummond 1953

I did not find this species, previously reported in the N.H.p. only once (Rageau & Vervent, 1958:20; Belkin, 1962:194-195).

Culex (Culex) quinquefasciatus Say 1823

Typically a domestic species, *Cx.quinquefasciatus* seems to spread over the N.H.p. extremely slowly: a characteristic which is corroborated by the fact that though Laveran had reported the presence of *Cx.quinquefasciatus* in Vila in 1901, Buxton, 25 years later, «found it in the same place, (but) never encountered a specimen anywhere else in the group, during four months' collecting» (Buxton & Hopkins, 1927:85). Of the reported breeding sites of this species (Rageau & Vervent, 1958:20) I never found *Cx.quinquefasciatus* in temporary ground pools or in ditches — probably due to the (dry) seasons of my collections —, whereas specimens were found, as expected, in 170-liter drums, stranded canoes, and in a large cylindrical concrete container: always in rainwater, in general polluted. There were 2 more unusual collections: in a small treehole of *Ponciana*, in the courtyard of a field dispensary, associated with *Cx.pacificus, Ae.aegypti* and *Ae.hebrideus* (Malekula I., 750823/1); and in a rat-gnawed coconut husk with foul contents (Tanna I., 750804/1).

Culex (Culex) sitiens Wiedemann 1828

The breeding sites where this species was found fully agree with those reported in the

N.H.p. in past literature (Buxton & Hopkins, 1927:79: Rageau & Vervent, 1958:22: Belkin, 1962:206-207): canoes, coral holes, rock holes, muddy pools on coral soil, in general with brackish water. Never far from the sea, with the single and notable exception of 751008/5. Though the new insular records show now a continuity from Espiritu Santo I. to Futuna I., the species seems absent on some islands, probably because of the specific breeding necessities — and consequent limited spread — of *Cx.sitiens*. Typically, on Malekula I. extensive search detected *Cx.sitiens* only once, in coral holes, associated with *Ae.hebrideus* (710912/5,:8,/9). The larvae collected on Aniwa I., breeding with *Ae.(Och) vigilax* and *Ae.hebrideus*, show strongly flattened 1-C, with irregularly shaped margins.

Culex (Culex) annulirostris Skuse 1889

The present findings more than double the existing insular records of *Cx.annulirostris*, and add important islands (Aoba, Maewo, Pentecoste, Paama, Epi, Erromango, Aniwa) and a few minor islands and islets. This species has been found in the whole array of its reported breeding sites (Rageau & Vervent, 1958:22; Belkin, 1962:209), in general on the ground but not rarely in canoes and various types of artificial containers. Unusual findings were: a treehole (Malo I., 750908/1); a rat-gnawed coconut husk (Aoba I., 710706/5; Malekula I., 750822/18). *Cx.annulirostris* can be found associated with many other mosquito species, in a variety of combinations. Second to *Ae.hebrideus*, *Cx.annulirostris* is, with *Cx.pacificus*, *An.farauti* and *Tp.melanesiensis*, the most widespread species in the N.H.p.

As noted by Belkin (1962:209), the larvae of *Cx.annulirostris* show variations of the lenght of the siphon related to different habitats.

Culex (Culex) starckeae Stone & Knight 1958

In the N.H.p. this species had been reported only from Espiritu Santo I., in mats of filamentous green algae along the margins of streams and in stream pools (Rageau & Vervent, 1958:23; Belkin, 1962:218). I found it again on Espiritu Santo's western part, in 2 occasions: in typical breeding sites, along the coast, with *An.farauti* associated (710901/5), and in mats in canals with taro (*Alocasia* sp.), associated with *An.farauti* and *Cx.annulirostris*, inland, at appr. 100 m above sea level (710903/1).

In addition, *Cx.starckeae* was found twice on Efate I.: in typical breeding sites along the margin of a stream, associated with *An.farauti* (750726/3), and in a large borrow pit, rich in mats of filamentous green, algae, on the bank of a river, associated with *Cx.annulirostris* (750918/2).

Culex (Eumelanomya) femineus Edwards 1926

The specimens were found in general in breeding sites which agree with past evidence (Rageau & Vervent, 1958:24; Belkin 1962:237), e.g.: in rock pools or rockholes along streams, or in wells, with clear waters, sun-shaded or shaded, and some leaves or debris. A few exceptions are worth to be noted: on Rano I., a single larva in rainwater of a 170-liter drum (750901/1:ii) — reminiscent of Salaun's finding on Pentecoste (Rageau & Vervent, 1958:24) —; on Tanna I., in a small water collecting basin hewn in a tufa wall (750926/3). The capture of adults resting underground (Uri I., 750818/4) agrees with Perry's report (Rageau & Vervent, 1958:24).

The finding of *Cx.femineus* breeding sites on rockholes, along the Voluelei T., on the western slopes of the central mountain chain of Espiritu Santo I., al 1000 m, is notable, even for a species already reported inland and in altitude (Laird, 1956:276).

Culex (Lophoceraomyia) buxtoni Edwards 1926

My few findings confirm that in the N.H.p. this species in relatively rare, and probably not yet fully known (Rageau & Vervent, 1958:24; Belkin, 1962:256).

Aedes (Ochlerotatus) vigilax (Skuse 1889)

Contrary to a recent statement (Rodhain & Fauran, 1975 a:541), in the N.H.p. *Ae.vigilax* has been found rarely. As a matter of fact, the single finding by Perry on Espiritu Santo I., in 1944 (1946:18), remained as the sole record — according to Laird (1956:82-83) and to Rageau & Vervent (1958:16) — until Belkin reported this species as found also on Aessi I. (1962:395). On these northern islands of the N.H.p. *Ae.vigilax* has been considered to be either indigenous

or introduced from New Caledonia and/or the Loyalties. For an isolated island as Aniwa the former hypothesis seems more valid.

Ae.vigilax is primarily a brackish water-breeder, strictly related to mangrove swamps and salt marshes (Rageau & Vervent, 1958:16; Belkin, 1962:395). On Aniwa I. the breeding site is of the latter type. The associated species were *Cx.sitiens* and *Ae.hebrideus*. Females of *Ae.vigilax* and of *Ae.hebrideus* were caught attacking, at 10 a.m., in the oper.

Since in New Caledonia and in the Loyalties *Ae.vigilax* has been shown to be an important vector of nonperiodic filariasis (Belkin, 1962:395), it could be worth investigating whether this species has any impact on Aniwa I. for the spread of periodic (?) filariasis, which is present on the island in spite of the fact that *An.farauti* is rare.

Aedes (Verralina) lineatus (Taylor 1914)

«In the New Hebrides, Buxton found adults numerous in several places, and they bit savagely during the day in swamps. The larvae were never discovered». So say Buxton & Hopkins about the search of *Ae.lineatus* in the N.H.p. (1927:101) : a statement perfectly valid for my case, since — though focussing on aquatic stages, and uninterested in imagos — I got comparatively more imagos than immature stages than for any other species (Table 1). Contrary to past expectations (Rageau & Vervent, 1958:18), I found *Ae.lineatus* distributional area quite limited: this species seems to be absent south of Efate I. In altitude, however, *Ae.lineatus* has been reported at 1200 m height at Crater Lake, on Aoba I. (Belkin 1965:15). My breeding sites were as said in the literature (Rageau & Vervent, 1958;18; Belkin, 1962:419). The most common associated species found has been *An.farauti*, followed by *Ae.(Adm) nocturnus*.

Aedes (Aedimorphus) nocturnus (Theobald 1903)

To the previous insular records I could add those for Aore, Aoba, Malekula, Kulivu and Ahamb. The breeding sites were in general as reported by Rageau & Vervent (1958:16) and Belkin (1962:429), and the associated species were mainly *An.farauti, Cx.annulirostris* and *Ae.lineatus* — in varied combinations — and, once, *Cx.sitiens*. An unusual finding was that of *Ae.nocturnus* in a 170-liter rainwater drum (Malekula I., 750824/2).

Since this species can show dramatic increases after heavy rains (Belkin, 1962:429), my dry seasons' collections can add little to the knowledge of *Ae.nocturnus* in the N.H.p.

Aedes (Stegomyia) aegypti (Linnaeus 1762)

Though circumstantial evidence may suggest possible vectorial roles of other *Stegomyia* species, in the N.H.p. *Ae.aegypti* remains the sole or main vector of dengue fevers (WHO, 1976:115-116)°.

A domestic pest which breeds primarily in artificial containers, and a urban mosquito, *Ae.aegypti* has been found in relatively few of the islands of the N.H.p., and in small foci. Laveran first found it on Efate I. in 1901, and Buxton in 1925 confirmed its presence there — in Port-Vila — and found it also on Tanna I. (Rageau & Vervent, 1958:16). Reported in 1946 by Perry on Espiritu Santo I., *Ae.aegypti* has never since been found there, in spite of careful search and of serological evidence of dengue fevers (Rhodain & Fauran, 1975, a:541-542). Since a few years *Ae.aegypti* is increasingly present on Efate I., and particularly in the Port-Vila area: here it has been found and reported by the Condominium Health Services (unpublished), Rhodain & Fauran (1975, a:541) and van Seventer (1973:2). The latter found *Ae.aegypti* also on the Irikiri and Fila islets, just off Port-Vila (1973:2); I collected this species on Mele islet (750810/2) and at Panangisu Village (710823/4). *Ae.aegypti* has been reported by van Seventer as present on Tanna I., again, on Erromango I. and on Epi I. (1973:2). I found it on Malekula I. (750823/1), Paama I. (710727/4) and Makura I. (750705/2,/3).

My findings deserve a few words of comment. The epidemiological risks that the presence

° Data and analysis are limited to up to the end of 1975.

of the vector of dengue fevers in the courtyard of a small hospital involves are obvious (see under *Cx.quinquefasciatus*). The same applies to Makura I., where a peculiar and clever way of storing water may become an important source of vectors. As for the finding of *Ae.aegypti* in the remote village of Tevie, at the extreme northern tip of Paama I., I suspect that the species has been introduced there through the visits of the small inter-island boats, on which most of the Tevie men are sailors. The dispersal of *Ae.aegypti* may have been favoured by the practice, usual on these small boats, to store and transport drinking water in 170-liter drums — one of the known ways of dispersal by human agency (Belkin, 1962:51-52). The introduction on the small islands of Vao and Ahamb, near Malekula I., from which *Ae.aegypti* has been reported (unpublished Condominium H.S. report), may well have happened through a similar mechanism.

Aedes (Stegomyia) aobae Belkin 1962

In the past, in the N.H.p. *Ae.aobae* had been reported only from Aoba I., where D.Bonnet found it in August 1956, twice: first at the very top of the island, near Crater Lake, at approx. 1200 m height, in a treehole in deep shade (8 ♀ ♀, 7 ♂ ♂, 6 L, 5 P), and later nearer to the coast, in deep forest near the Episcopal Girls' School, 2 ♀ ♀ biting in daytime (Belkin, 1962:452-453; Belkin, 1965:15).

Belkin, however, noted that a single female captured in October 1929 by L.E. Cheesman on Vanua Lava, in the Banks, was entirely similar to the type material (1962:453). This point has been confirmed by recent findings, reported elsewhere, which show that in the Banks and Torres island group *Ae.aobae* is a common and widespread species (Maffi & Taylor, 1977: 519,520).

During my quite long visit to Aoba I. I never found *Ae.aobae*. Apart from the possibly negative factor of the dry season, the failure is probably due to the insufficient time devoted to the upper, and uninhabited, parts of the island. The Crater Lake was never visited. A few days later, however, and quite unexpectedly, while visiting Pentecoste I. — which, at its nearest point, is only 50 km distant from Aoba I. —, I found *Ae.aobae* in two occasions, both along the western coast, facing Aoba I.,: in a treehole in light coastal woods, associated with *Ae.hebrideus* (710710/8), and later in a dry coconut husk, with foul contents, associated with *Ae.hebrideus* and *Tp. (Rah) melanesiensis* (710722/1). The presence of *Ae.aobae* in the Banks and Torres — already known, and now confirmed — and on Pentecoste I. adds interest to Belkin's suggestions on the possible geographic differentiation of the mosquito fauna in the New Hebrides (1962:28-29,453).

As reported elsewhere (Maffi & Taylor, 1977:519,521), circumstantial evidence has lead to suspect *Ae.aobae* as the local vector of fevers reminiscent of dengue which hit the Banks group in the fall 1975. Should this be the case, the presence of a wild and aggressive vector as *Ae.aobae* is on populated islands like Aoba and Pentecoste would be a serious cause of concern.

Aedes (Stegomyia) hebrideus Edwards 1926

Tho the past insular record for this species — most of them confirmed — have been added those of its presence on the islands of Aoba, Maewo, Paama, Emae and Aniwa, as on all the small islands or islets I have been able to visit. Erromango I. is the sole large island on which *Ae.hebrideus* has not yet been found: therefore, it can be said that this is the most widespread species of mosquito in the N.H.p. Since *Ae.hebrideus* is also the most widespread species in the Banks and Torres groups (Maffi & Taylor, 1977:519,520) the statement is valid for the whole subarea.

Ae.hebrideus is usually found in its typical breeding sites (Rageau & Vervent, 1958:17; Belkin, 1962:459-460). However, it was collected also in: rock pools, either at sea-shore (710723/4) or with freshwater (710724/2), on Ambrym I.; coral pools, sometimes associated with *Cx.sitiens* (710912/6,/7,/8), on Malekula I.; rockholes on boulders (751008/2), on Nguna I.

In relation to diseases, in the N.H.p. *Ae.hebrideus* has been suspected, for some time, to be the vector of both human periodic filariasis and dengue fevers (Rageau & Vervent, 1958:18).

Shortly later, however, the vectorial capacity for filariasis resulted to be unfounded and that for dengue doubtful (Belkin, 1962:460). Investigations on the recent dengue epidemics in the N.H.p. (1972 and 1974) have lead to propose again the role of dengue vector for *Ae.hebrideus* on Espiritu Santo I., where high rates of serological positivities amongst the inhabitants have been obtained but *Ae.aegypti* was never found (Rhodain & Fauran, 1975, a:542-543). The available circumstancial evidence of this vectorial role of *Ae.hebrideus* is not fully convincing, and additional research is needed. An interesting line of thought, already present in Perry (1948:254), is that sibling species may be present in *Ae.hebrideus*, each with different vectorial potentialities: a definite possibility in this variable species (Belkin, 1962:258-259).

It is in *Ae.hebrideus* that the first and only *Coelomomyces* infection in the N.H.p. has been reported (Rhodain & Fauran, 1975, b).

Aedes (Stegomyia) pernotatus Farner & Bohart 1944

By adding the islands of Ambrym, Epi and Emae to the former insular records, my findings have increased the area of distribution of *Ae.pernotatus*. In its breeding sites — that are in general as reported (Rageau & Vervent, 1958:18; Belkin, 1962:466) — *Ae.pernotatus* is associated mainly with *Ae.hebrideus*, to a lesser extend with *Cx.pacificus* and *Tp.melanesiensis*. As reported on Aneityum I., where *Ae.pernotatus* was found in two occasion in a «large hole in boulder», once associated with *Cx.annulirostris* and *Ae.hebrideus* (Laird, 1956:24), I found this species on Ambrym I. in a rock pool, at the sea-shore, associated with *Cx.pacificus* and *Cx.sitiens* (710723/4). Again, as *Ae.pernotatus* on Aneityum I. was in 170-liter drum (Laird, 1956:22), I found it on Epi I. in clear rainwater in a discarded paint pail, associated with *Tp.melanesiensis* (710730/5). On Malekula I. this species was collected breeding in a discarded truck tyre, associated with *Cx.pacificus* and *Ae.hebrideus* (750701/1).

The possibily that *Ae.hebrideus* and *Ae.pernotatus* may develop in nature intermediate forms, and that different populations may exist on the various islands of the New Hebrides, has been exhaustively treated by Belkin (1962:459,465), and my collections, casual and lacking in individual rearings, have nothing new to add. A few practical points, however, seem worth noting.

In general I found quite easy to identify the aquatic stages of *Ae.hebrideus* and *Ae.pernotatus*, using the keys and figurations by Belkin (1962:439-441, Figs. 331, 332, 339-340). However, in a limited number of larvae it could be noted that whereas the other morphological characters were typical of *Ae.hebrideus* — and so I identified them — the comb scales on segment VIII were showing the strong basal denticles on the free portion (usually in part) suggestive of *Ae.pernotatus*. Such larvae were collected particularly from: i) large collections of water, favourable to the development of relevant populations, as : canoes (710914/1,/4,/5) and big treeholes (710912/2,/3);ii) very small breeding sites, necessarily crowded, as : coconut husks (750822/11,/15) and *Tridacna* shells (751119/4,/5).

Tripeteroides (Rachionotomyia) melanesiensis Belkin 1955

The presence of this species has been confirmed on most of the islands of the N.H.p. on which it had been reported in the past, and ascertained on several others, namely: Malo, Maewo, Ambrym, Paama, Epi, Emae, Wala, Uripiv, Nguna and Tanna. Therefore, in the N.H.p. *Tp.melanesiensis* is amongst the most widespread species.

Though some valuable data on the distribution and bionomics of *Tp.melanesiensis* are given by Rageau & Vervent (1958:26-27), it is in Belkin's contributions that the species is fully described and represented (1955:233-243, figg.3-5; 1962:515-517,Figg.383-384): with particular attention to the larval stage, which shows morphological variations basically related to the habitat and to the latitude.

The larval material I have collected agrees with the patterns detailed by Belkin: however, this seems more true for the variations related to specific habitats than for those related to geographical locations. In the latter case correspondences are less frequent and/or clear.

The pupae collected show morphological characters which in general agree with those known for *Tp.melanesiensis* typical and atypical races (Belkin, 1955:234,237; 1962:515-516,Fig.384). It is worth noting, however, that the pupae from the southern parts of

the N.H.p. — in particular: from Tanna I. (750805/1; 750926/4,/6) and from Aneityum I. (751116/1) — show morphological features which are considerably reminiscent of *Tp. (Rah) caledonicus*. Outside these southern islands, similar characters are shown only by the pupae of one of the Malekula I. 's collections (750701/1). These pupal specimens — adding to the scanty material available for the N.H.p. — may be of some interest for a future further study of the *caledonicus* group and/or the *melanesiensis* complex (Belkin, 1955:221-227; 1962:507,512-513,516).

In this context, it should be noted that also at the northern end of the New Hebrides subarea, in the Torres group, some pupae of *Tp.melanesiensis* show variations from the standard morphology, suggesting *Tp. (Rah) rotumanus* (Maffi & Taylor, 1977: 520,521).

CONCLUSIONS

Visiting the islands of the New Hebrides proper as malaria consultant, my investigations on and collections of the local malaria vector, *An.farauti,* were pertinent, and those of the known or suspected vectors of other mosquito-borne diseases, *Ae.aegypti, Ae.aobae, Ae.hebrideus, Ae.vigilax* — or even *Cx.annulirostris* — could be justified. Those of other species of Culicidae, however, had to be — and indeed have been — casual, and limited to the islands visited for malaria and to the spare time available. It is evident that proper entomological collections, inclusive of individual rearings, would have yielded more rewarding results, particularly in taxonomy and systematics.

A first point to be noted — to confirm what has been said half a century ago by Buxton and Hopkins (1927:67-68) — is that in the N.H.p. not only breeding places are neither frequent nor easy to find (at least, during the dry season) but that quite often breeding places apparently suitable for the mosquito fauna yield negative results. This is particularly noticeable moving from north to south: even duly considering the known decrease in species present, and the more marked seasonal impact of the climate. Therefore, the 247 collections of Culicidae obtained represent a considerable greater effort.

Because of the abovementioned rules of collecting, of the 22 species of Culicidae that have been reported in the past from the N.H.p. (Belkin, 1962:28, fig. 8) 5 were never found, namely: *Cx. (Cux) australicus,* a questionable record, *Cx. (Lop)* Aoba form, a rare species, and *Ma. (Coq) xantogaster, Ae. (Geo) daggyi* and *Tp. (Rah) folicola,* 3 species with peculiar and uncommon breeding sites (Belkin, 1962:28-29, 194-195, 269, 312, 336, 518). Actually, no effort was made to locate these 5 species.

All the other 17 species reported in the past were found. The number of specimens for each single species, however, goes from 1 single larva of *Ur.barnesi* — thus confirming the rarity of the species in the N.H.p. — to the 713 specimens of *Ae.hebrideus* — almost 1/3 of the total of 2 671 specimens of mosquitoes I have obtained (Table 1). Here again, a proper entomological survey would have achieved more balanced and significant results.

TABLE I. Culicidae of the New Hebrides island group proper. Material examined, by species and by stage.

Species	Larva (L)	Larval skin (l)	Pupa (P)	Pupal skin (p)	Female ♀	Male ♂	Total by species
An.farauti	182	3	27	5	8	5	230
Ur.barnesi	1						1
Cx.pacificus	268	1	52	5	3	—	329
Cx.quinquefasciatus	40	—	2	1	1	1	45
Cx.sitiens	95	1	44	—	—	—	140
Cx.annulirostris	339	8	45	43	17	13	465
Cx.starckeae	14	—	4	10	4	3	35
Cx.femineus	93	—	15	—	1	2	111
Cx.buxtoni	13	—	3	—	1	1	18
Ae.vigilax	5	—	3	—	3	—	11
Ae.lineatus	24	—	26	—	20	—	70
Ae.nocturnus	37	—	2	5	2	—	46
Ae.aegypti	24	—	—	—	1	—	25
Ae.aobae	14	—	1	—	—	—	15
Ae.hebrideus	440	1	215	12	30	15	713
Ae.pernotatus	93	1	7	7	5	5	118
Tp.melanesiensis	220	5	52	14	4	4	299
Total by stage	1902	20	498	102	100	49	2671

With respect to the distribution of the mosquito fauna on the islands of the N.H.p. the contribution has been positive: my findings have raised the previous total insular record of 138 presences by species to 232 (Table 2).

As expected, new records are absent or minor for those islands that are larger and/or entomologically best known, namely: Espiritu Santo Malekula, Efate, Aneityum. No new records have been added both for Espiritu Santo and Aneityum. For Espiritu Santo, however, some of the findings are interesting: the diffuse breeding of *An.farauti* along the western coast and inland of it; the presence of *Cx.starckeae* inland and up to 100 m; the presence of *Cx.femineus* at 1000 m height. On Aneityum I. — of which I visited only the southern coast — I was able to confirm only 6 of the reported 8 species. For Malekula I., mainland, 3 insular records, were added: *Cx.sitiens, Ae.nocturnus* and *Ae.aegypti*. Though limited to a single collection, the presence of *Ae.aegypti* is of ominous significance. A single but interesting record has been added for Efate I.: *Cx.starckeae,* until now reported — and confirmed — only on Espiritu Santo I.

New records have been more easily established for the less known islands and/or for the smaller islands and the off-shore islets. Amongst the latter groups, however, have not been visited the islands off Espiritu Santo I., and very cursorily visited Malo and Aore Is.

Numerous records were added to the relatively few existing for the eastern chain os islands of the N.H.p. (Maewo, Pentecoste, Ambrym, Paama), for most of the islands of the Shepherd group (Epi, Emae, Makura, Mataso) and for Aoba I. For the latter the insular records are now almost doubled, showing — amongst other species — the presence of *An.farauti* and *Ae.hebrideus*. Against my anticipations, on Aoba I. I was unable to find *Ae.aobae* — probably for reasons already detailed —; however, unexpectedly, I found this species on the western coast of Pentecoste I.: the first, and up to now sole, record of the presence of this species anywhere in the N.H.p. outside Aoba I. Other new insular records on the abovementioned islands are those of *An.farauti* on Maewo, Pentecoste, Epi and Mataso, of *Ae.aegypti* on Paama and Makura, of *Ae.pernotatus* on Ambrym, Epi and Emae. As for *Cx.pacificus*, *Cx.annulirostris*, *Ae.hebrideus* and *Tp.melanesiensis*, summing old and new insular records they appear to be all over. Buninga I. is the only one to have yielded totally negative results. Tongoa and Tongariki Is. (Shepherd group) and the uninhabited volcanic Lopevi I. were not visited.

Good dividends paid also the visits to the small islands and islets off Malekula I. *An.farauti* was found breeding in village wells on Rano, Vao (confirmed), Kulivu and Ahamb: a relevant contribution to the campaign against malaria. *Cx.pacificus* and *Ae.hebrideus* — and *Cx.femineus*, in part — were found extensively present.

Of the smaller islands off Efate I. only two were shortly visited: Nguna and Mao. The results were rewarding: in addition to the usual widespread species, present on both, on Nguna I. was found *Cx.sitiens*, a species not yet reported from the Shepherd group and from Efate I. Common in Port-Vila and present in some other parts of Efate I., *Ae.aegypti* is breeding also on the islets off-shore of Port-Vila: Iririki, Fila and Mele.

Limited attention was paid to the N.H.p. islands located south of Efate I.: in general the visits were short — that to Futuna I. lasted a few hours — and the dry season was at its peak. In spite of this, a few results were of considerable interest. On Erromango I., large and uninhabited except for the coastal fringe, the search yielded negative results except for the finding of *Cx.annulirostris* (a new insular record) in 3 different localities far apart. On Tanna I., a few amongst the specimens of *Cx.pacificus* and *Tp.melanesiensis* collected (new insular records) show minor but not irrilevant morphological variations. On Aniwa I. were found, for the first time, *Cx.sitiens*, *Cx.annulirostris*, *Ae.vigilax* and *Ae.hebrideus:* the presence on Aniwa I. of *Ae.vigilax*, a species known in the N.H.p. only from Espiritu Santo I. and Aessi I. — both located far away, in the northern part of the territory —, is of particular

interest. On Aneityum I. were found again most of the species previously reported.

Summing up on the distribution of the mosquito fauna in the N.H.p. (Table 2) it appears that *Ae.hebrideus* is the most widespread species, present all over the territory from Espiritu Santo I. down to Aneityum I. Also a few other species, namely *An.farauti* (which is remarkably widespread), *Cx.pacificus, Cx.annulirostris* and *Tp.melanesiensis* can be found into the same extreme limits, although in a more discontinuous way. *Cx.quinquefasciatus, Cx.sitiens, Cx.femineus, Cx.buxtoni, Ae.nocturnus, Ae.aegypti* and *Ae.pernotatus* are species less frequently present, either because they are more scattered, with big gaps, or because they don't reach farther south than Tanna I.

Of the remnant species, *Ae.vigilax* is rare, and present only on a few islands far apart; *Ur.barnesi, Cx.starckeae, Ae.daggyi* and *Ae.lineatus* (the only one quite common) do not go farther south than Efate I.; and the others are found only in the north: *Ma.xantogaster, Cx.* Aoba form, *Ae.aobae* and *Tp.folicola*. The only relevant variations is the finding of *Ae.aobae* on Pentecoste I.

On the whole, it seems that of the dispersals which have interested the N.H.p. (Belkin, 1962:27-28, 54-57, figs. 20, 21) those reaching the N.H.p. from a southern and/or a southwestern direction have met, in general, with more success in spreading than those coming from the north, from the Solomons. The notable exceptions appear to have been *An.farauti* and *Ae.hebrideus* — for the latter, however, provided it came from there (Belkin, 1962:55,459). The reason for such different success in spreading may well be for the N.H.p. the more suitable natural — and human, in part — ecologies met by the mosquito fauna when moving in a northerly direction.

For a complete picture of the Culicidae in the N.H.p., however, it will be necessary to wait until a thorough entomological survey will cover the territory. At that moment this contribution may be of some value.

ACKNOWLEDGMENTS

I am greatly indebted to Dr B. Taylor and to Dr J.A. Tenorio for the identification of the 1971 and 1975 imagos, respectively. My thanks go to Dr W.A Steffan and to the staff of the Bishop Museum for their assistance in preparing the specimens.

To Dr J.N. Belkin I am indebted for his constant encouragement, and to Dr. T.L. Chang, Dr F.L. Oddo and Dr R.C.-B. Ratard for their permission to report on their unpublished findings.

I wish to express my sincere gratitude to the Condominium, French and British administrative and health authorities of the New Hebrides, and to the World Health Organization, for their support during my visits to the New Hebrides which made this paper possible.

REFERENCES

BELKIN J.N. (1955) — The *Tripteroides caledonica* complex of mosquitoes in Melanesia (Diptera: Culicidae). *Pacific. Sci.*, 9, 221-246.

BELKIN J.N. (1962) — *The mosquitoes of the South Pacific.* Univ. of California Press, Berkeley & Los Angeles, 2 vols.
BELKIN J.N. (1965) — The mosquitoes of the Robinson-Peabody Museum of Salem expedition to the Southwest Pacific. *Contrib. Amer. Ent. Inst., 1* 11-34.
BUXTON P.A. (1926) — The depopulation of the New Hebrides and other parts of Melanesia. *Trans. Roy. Soc. Trop. Med. & Hyg., 19,* 420-454.
BUXTON P.A., HOPKINS G.H.E. (1927) — Researches in Polynesia and Melanesia. I-IV. *Mem. Lond. Sch. Hyg. Trop. Med., 1,* 1-260.
CORNER E.J.H., LEE K.E. (1975) — A discussion on the results of the 1971 Royal Society-Percy Sladen expedition to the New Hebrides. *Phil. Trans. Roy. Soc. Lond., B. 272,* 268-486.
DAGGY R.H. (1945) — The biology and seasonal cycle of *Anopheles farauti* on Espiritu Santo, New Hebrides. *Ent. Soc. Amer., Ann. 38,* 1-13.
LAIRD M. (1955) — Mosquitos and malaria in the hill country of the New Hebrides and Solomon Islands. *B. Ent. Res., 46,* 275-289.
LAIRD M. (1956). — Studies on mosquitoes and freshwater ecology in the South Pacific. *Roy. Soc. New Zeal. B. 6,* 1-213.
MCARTHUR M., YAXLEY J.F. (1967) — *A Report on the First Census of the Population, 1967.* Blight Govt. Pr., Sydney.
MAFFI M. (1972) — Report of the WHO Consultant on the Malaria Survey in New Hebrides, 26 June — 25 September 1971. *WHO/WPRO, 2.5.72,* 1-74. Unpublished.
MAFFI M. (1976) — Assignment Report, 15 June to 5 December 1975. *WHO/WPRO, 12.1.76.* 1-14. Unpublished.
MAFFI M., TAYLOR B. (1974) — The mosquitoes of the Santa Cruz faunal subarea of the Southwest Pacific (Diptera: Culicidae). *J.Med.Ent., 11,* 197-210.
MAFFI M., TAYLOR B. (1977) — The mosquitoes of the Banks and Torres island groups of the South Pacific (Diptera: Culicidae). *Pacif. Ins., 17,* 511-522.
MAFFI M., TENORIO J.A. (1977) — *Culex (Culex) banksensis,* a new species of mosquito (Diptera: Culicidae) from the Banks Islands, New Hebrides. *Pacif. Ins., 17,* 503-509.
ODDO F.L., CHANG T.L. (1971) — Rapport sur la premièr partie d' une enquête sur le paludisme et la filariose effectuée dans l' archipel des Nouvelles — Hébrides (27 Mai — 8 Août 1970). *WHO/HQS,* 1-57 + 1-16. Unpublished.
PERRY W.J. (1946) — Keys to the larval and adult mosquitoes of Espiritu Santo (New Hebrides) with notes on their bionomics. *Pan-Pacific Ent., 22,* 9-18.
PERRY W.J. (1948) — The dengue vector on New Caledonia, the New Hebrides and the Solomon Islands. *Amer. J. Trop. Med., 28,* 253-259.
RAGEAU J., VERVENT G. (1958) — *Arthropodes d' intérêt médical ou vétérinaire aux Nouvelles-Hébrides.* 1-51. Inst. Franç. d'Océanie. Nouméa. Unpublished.
RAGEAU J., VERVENT G. (1959) — *Enquête entomologique sur le paludisme aux Nouvelles-Hébrides.* 1-34. South Pacific Comm., Tech. Paper 119.
RATARD R.C.-B. (1976) — *Epidemiology of Malaria in the New Hebrides.* 1-72. Thesis, Louisiana State University, U.S.A. Unpublisded.
REINERT J.F. (1975) — Mosquito Generic and Subgeneric Abbreviations (Diptera, Culicidae). *Mosq.System., 7,* 105-110,
RODHAIN F., FAURAN P. (1975a) — Résultats d' une enquête sur les vecteurs potentiels de la dengue aux Nouvelles Hébrides (1972 et 1974). *Bull. Soc. Path. Ex., 6,* 539-545.
RODHAIN F., FAURAN P. (1975 b). — Infection naturelle d' *Aedes (S.) hebrideus* par un *Coelomomyces* aux Nouvelles-Hebrides. *Ann.Parasit.* (Paris), *50,* 643-646.
VAN SEVENTER H.A. (1973) — Report on the entomological studies in the New Hebrides, 30 December 1972 to 28 April 1973. *WHO/WPRO, 16.7.73,* 1-9. Unpublished.
W.H.O. (1976) — Dengue fever surveillance in some countries of Asia and the South-west Pacific. *Wkly Epidem. Rec., 51,* 113-120.

TABLE 2. Conspectus of the Culicidae of the Hebrides island group proper (N.H.P.), by species, islands and main sources of reporting.

Dolphin I.	Pilot I.	Turtle (Mafia) I.	Aesi I.	Tutuba I.	*Aore I.*	*Malo I.*	Ulilapa I.	Venui I.	Tangoa I.	Araki I.	Aoba I.	Maewo I.	Pentecoste I.	Ambrym I.	Paama I.	Lopevi I.	*Epi I.*	Tongoa I.	Tongariki I.	*Emae I.*	*Buninga I.*	*Makura I.*	*Mataso I.*	*Malekula I. mainland*	*Vao I.*	*Atchin I.*	*Wala I.*	*Rano I.*	*Uripiv I.*	*Uri I.*	Sakau I.	*Kultivu I.*	*Ahamb I.*	Toman I.	*Efate I. mainland*	Fila I.	Iririki I.	*Mele I.*	Hat I.	Leleppa I.	Moso I.	*Nguna I.*	Pele I.	*Mau I.*	*Erromango I.*	*Tanna I.*	*Aniwa I.*	*Futuna I.*	*Aneityum I.*	No. of islands on whih species found (& prevision record)
					+	⊕					O	O	O	⊕			O			+			O				O	O				O	O																23 (16)
																	O																		–															3 (2)
				+		⊖	–		–		⊕		O	⊕	O		⊕			O				⊕	+		O		O	O		O	O		⊕			O				O		O		O				23 (11)
																																																		1 (1)
				+							⊕													O	+				O			O			⊕													⊖			⊕	10 (8)
					–		–	|	+		O	+	+	O	O									Ò									O	O												+	O	+		17 (9)
				+	⊕	⊖	–					O	O	O	O			O			+			O	⊖	O					O					⊕					–		O		O	O	⊕	O		⊕	23 (11)
																																			O																2 (1)
				+							O		+	⊙			O							+	–			O	O	O			O		⊖										–	⊕				15 (8)
				+	–						O													+											⊕														+	7 (6)
											+																																									1 (1)
					+																																															2 (2)
							–						+																						+														O			4 (4)
			–																																																	3 (2)
					+						+	O	O				⊕			⊕				⊕							O			+																10 (7)
					O						O									⊕				O							O	O		⊕													+	+	10 (5)
									–						O							O		O										⊕	⊥	⊥	O							⊥	+				11 (7)
											+		O																																							2 (1)
			|			–	–		+		O	O	⊕	⊕	O		⊕			O		O		⊕	+	|	O	O	O	O		O	O		⊕				–		O		O		⊕	O	+	⊕	30 (16)
					+	–							–	O			O			O				⊖									O		⊖			O										⊕	12 (7)
			+	+	+	O					⊕	O	⊕	O	O		O			O				⊕	+		O		O					+							O			–	O		+	⊕	22 (12)
																																																				1 (1)
			3 (3)	6 (6)	9 (8)	6 (5)	5 (5)	1 (1)	4 (4)		13 (7)	6 (1)	11 (6)	8 (3)	5 (0)		9 (3)	1 (1)		8 (4)		2 (0)	2 (0)	13 (10)	7 (6)	2 (2)	3 (0)	3 (0)	5 (0)	4 (0)		7 (0)	7 (0)		15 (14)	1 (1)	1 (1)	3 (0)		2 (2)		6 (1)		3 (0)	5 (4)	6 (7)	5 (1)	4 (4)	8 (8)	232 (138)