

# MONARCH BUTTERFLY DISPERSAL IN NEW ZEALAND

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*Abstract.* Following tagging of Monarch butterflies (*Danaus plexippus* (L.)) in North America and Australia, a tagging project was carried out in New Zealand as part of a study on insect dispersal. The project is described. A corrected overall recovery of 12.4% was achieved from over 6500 releases, during the seasons 1967/68 — 1973/74. Only 28 flights over 20 km were recorded and these are treated in detail. Most of these are accepted as genuine flights but gave no indication of regular long distance movements or migration. Three overwintering colonies are described; seasonal presence ('winter') and absence ('summer') is known but no inward or outward movements were recorded. Adult longevity is compared with time of year. Dispersal information is included. Monarch butterflies are recorded from the length of New Zealand in summer-autumn and are confirmed as spending winter periods locally in the North Island, separate from moving groups which appear in overwintering colonies.

An insect dispersal project, planned in 1967, was begun with the tagging of Monarch butterflies, *Danaus plexippus* (L., 1758) in February, 1968, near Auckland in the North Island, New Zealand (Fig. 1).

The well-known work of Professor F.A. Urquhart on the Monarch butterfly in North America, which included tagging butterflies, was available (Urquhart 1960), and C.N. Smithers, of The Australian Museum, provided information on his butterfly tagging programme then being carried out in Australia. Amongst other butterflies, Smithers was observing, recording and tagging *Danaus plexippus* (known as The Wanderer in Australia) near Sydney (Fig. 1) and elsewhere (Smithers 1965, 1972).

The Monarch butterfly is the largest and often the most obvious butterfly (except for the garden prevalent pest the White butterfly, *Pieris rapae* (L.)) in built-up areas in the north of New Zealand. It is, however, an introduced species, and perhaps an occasional immigrant from Australia as are the Blue Moon butterfly (*Hypolimnas bolina nerina* (Fab.)) and others.

*Danaus plexippus* is endemic to North America where the larval foodplants are milkweeds of the family Asclepiadaceae. The species has spread or been spread through the Pacific and it has survived where suitable foodplants grow. It is an introduced species or at the least an assisted immigrant in Australia and New Zealand where it has arrived in the last 150 years. In Australia, where introduced milkweed plants grow wild, it is established but in New Zealand it is still largely dependent on milkweeds (particularly *Asclepias fruticosa* L., the Swan plant) grown in home gardens. Foodplants in Australia have been recorded by Smithers (1973a) and in New Zealand have been discussed by Wise (1963) and Ramsay (1964a).

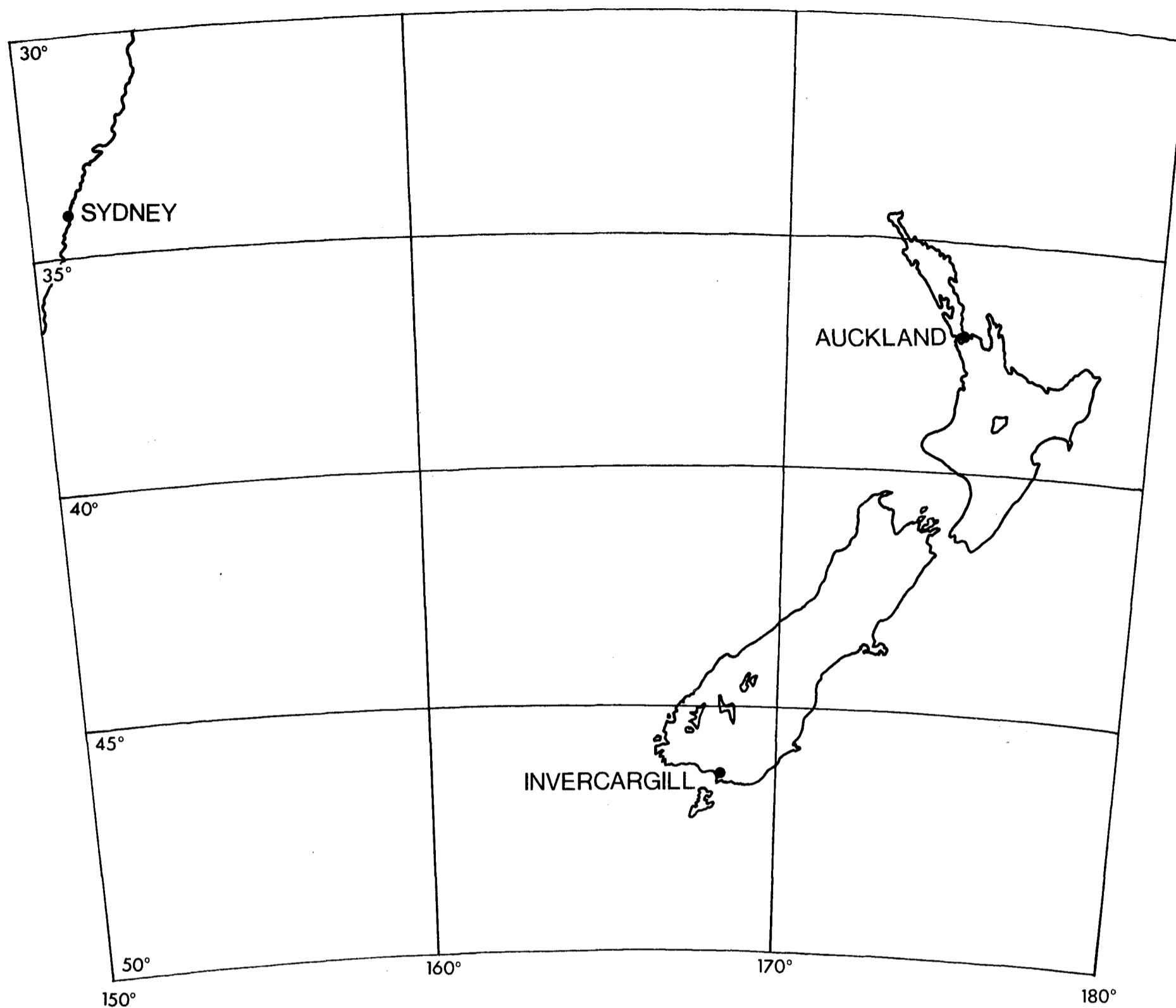


Fig. 1. South-eastern Australia and New Zealand showing the relative southern positions of Sydney, Auckland and Invercargill.

In North America, *Danaus plexippus* overwinters in southern United States areas and Mexico (Urquhart 1960). From there breeding populations migrate and spread northwards, as far as Canada, in the spring and summer, then individuals (of a subsequent brood) migrate southwards to the same overwintering grounds in the autumn. In Australia overwintering clusters and movements were known (Smithers 1965) but not their extent.

In New Zealand little was known of Monarch movements at the time the present project was planned, in 1967. The general impression was that Monarch butterflies spread to various parts of the country during the summer, sometimes as far south as Invercargill (Fig. 1), that they were more common in some summers than others and that sometimes individuals could be seen flying on sunny days during winter. Three overwintering centres were recorded (Ramsay 1964b), a colony in the far north at Tauranga Bay near Whangaroa Harbour on the east coast, one in a park in Hastings and scattered groups in Nelson in the north of the South Island (Fig. 2).

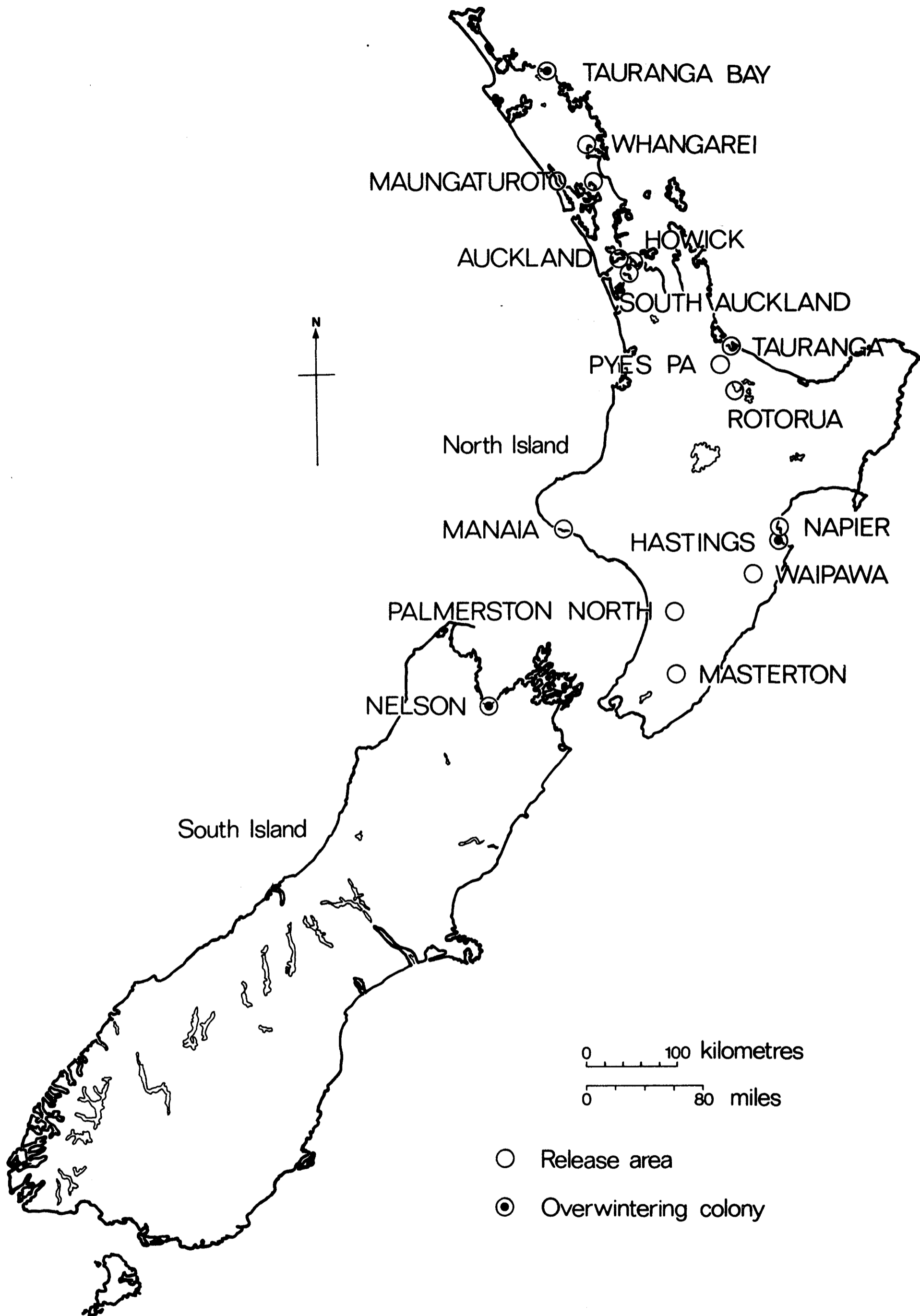


Fig. 2. Map of New Zealand showing main release centres of tagged Monarch butterflies and areas of overwintering colonies.

## THE TAGGING PROJECT

The tagging project began with the assistance of an enthusiast, Mrs K.S. Atkinson, of Howick near Auckland, who was breeding Monarch butterflies, and tagging was started in February, 1968. Subsequently many others acted as co-operators in various other parts of New Zealand and the programme was continued until 1974. Most of the tagging was carried out on reared butterflies but others were tagged when caught. In addition, some butterflies were tagged in the overwintering colonies in Nelson and Hastings while many were tagged in the northern colony at Tauranga Bay. The main centres where tagging was done and the three overwintering colony areas are indicated in Fig. 2.

In both Australia and New Zealand, the summer period spans the end of one year and the beginning of the next. However, in New Zealand, while a three-month summer period may be considered to be over December-January-February, the highest temperatures may be in January-February-March or even February-March-April in some years. It seems that adult Monarchs of a new post-winter brood do not appear until November-December and tagging in various places in different years has not begun until November, December or following months in the next year. The adult and consequent tagging season is considered here to begin in November each year so that the seasons of the project are designated 1967/68, 1968/69, through to 1973/74. It must be emphasised that tagging was begun in February, 1968, and that most of the tagging of 'summer' populations was done in the January-May periods (particularly February-April). Overwintering populations were mainly tagged in March-April, also May-June, at Tauranga Bay, in April at Hastings and in June-August at Nelson.

*Materials and methods*

Tags used for this project are *ca.* 14 x 8 mm, white paper printed on one side "RETURN TO AUCKLAND MUSEUM" with a self-adhesive coating on the other, supplied on rolled strips of backing paper in dispenser boxes. Prior to tagging, the labels were numbered consecutively across one end by hand and the strips cut in lots of 50 tags. Each 50-tag strip was associated with a 50-line record sheet with the same numbers written in the left-hand column. The record sheet contained the name of the marker and columns for label numbers, release sites, dates of release, sex, species and notes. A master record was kept of numbers on 50-tag lots, name of marker for each lot, and dates on which record sheets and tags were sent and returned.

It was thought very important to keep all concerned well-informed and co-operators were first of all supplied with a set of instructions on catching, tagging and recording. A butterfly condition code was introduced for use by co-operators and for recording results, as follows:-

T — Transient (that is, caught in passing), R — Reared, F — Fresh, O — Old, B — Battered, and in addition for use at recovery A — Alive, D — Dead. Thus at release a condition might be T/O or R/F and at recovery F/D or O/B/A, or any other condition.

Recovery of information was often from members of the public, being by return of butterfly plus tag or of tag alone, or by written or verbal (usually per telephone) advice. While it may be thought that such verbal advice may be less reliable than written advice, this was not necessarily the case as it was often possible to have the number checked and the recovery data confirmed at the time. Two standard letters were always used after

receiving recovery information. One acknowledged the information received, explained the project and supplied release data as a matter of interest; the other advised the co-operator and supplied both release and recovery data so the co-operator could easily see the results from releases. If the record sheet had not been returned at the time of recovery another standard letter was sent first to obtain the release data from the co-operator. A few newsletters (5 in all) were also sent to co-operators (between May, 1968, and December, 1971) giving relevant interesting information and a list of co-operators at the time.

Occasionally, daily newspapers in various centres ran stories which gave publicity to the project and sometimes helped to retrieve information and to make new contacts.

#### *Release and recovery*

During the period of seasons 1967/68 to 1973/74, a total of 25 co-operators plus the author and assistants tagged Monarch butterflies at approximately 35 different sites, mostly in the North Island. The recoveries from these releases were very satisfactory although there was a considerable range of percentage recovery (from nil to 100% when a very few were released and found). In order to indicate the numbers tagged and released and to demonstrate a general range of numbers and percentages of recoveries, records of tagged butterflies given in Table 1 are limited to those when 100 or more butterflies were tagged and released in a season, together with the overall figures for all seasons. These are based on original releases and do not include re-releases and re-recoveries. It is seen that, of over 6500 releases made, more than 1000 were recovered. This is an excellent result but it raises the question of whether too many recoveries too close or too soon may prevent longer flights. This was covered to some extent by allowing the recording of data and re-release when possible.

It should be pointed out that the total recoveries include those of individuals tagged at overwintering sites, where only local flights would be expected because of the cage effect of an overwintering colony in the 'winter'. For this reason a corrected total, excluding such recoveries in overwintering colonies, is given in Table 1 in order to present a more accurate overall recovery percentage.

#### *Flight distances*

Concerning the dispersal programme the most important factor arising from the tagging project was that of the distances travelled by tagged butterflies. These can only be recorded as straight-line distance from release point to recovery point and as such represent minimal distances of flight. They do not allow for wandering, doubling back or flights out and back. In order to indicate a general range of distances recorded during this project, Table 2 provides records from the recoveries of Monarch butterflies tagged over several seasons by three co-operators in the three main centres of tagging, Whangarei, Howick and Napier.

From these examples in Table 2, it is seen that the great majority of recorded distances were less than 20 km, which is not far for a recognised migrant and strong-flying species. Even where recovery/release/re-recovery took place flight distances, for the most part, remained short. Out of the total 1011 recoveries from all releases there are only 28 records of flights further than 20 km. For the purpose of this project these 28 are considered as long distance flights and are treated in more detail below.

Table 1. Numbers of Monarch butterflies released\* and recovered.

Centre (Co-operator)	Season	No. released	No. recovered	% recovery
Howick (K.S.A.)	1967-68	134	20	14.9
	1968-69	221	7	16.7
	1969-70	291	31	10.7
	1970-71	290	40	13.8
	1971-72	400	3	15.8
Pyes Pa (B.H.B.)	1972-73	153	4	2.6
Waipawa (G.I.)	1967-68	142	7	4.9
Whangarei (W.P.) (Maunu)	1970-71	164	14	8.5
	1971-72	177	22	12.4
Rotorua (K.P.R.)	1969-70	103	22	21.4
Napier (S.R.)	1968-69	163	45	27.6
Maungaturoto (M.E.W.)	1971-72	100	6	6.0
Whangarei (C.W.)	1969-70	273	77	28.2
	1970-71	410	125	30.5
	1971-72	173	53	30.6
Howick (D.W.)	1969-70	100	14	14.0
Tauranga Bay (K.A.J.W.) (overwintering colony)	1968	191	8	4.2
	1969	1634	176	10.8
Overall numbers of releases and recoveries		6506	1011	15.5% recovery overall
Numbers of releases and recoveries with overwintering colony recoveries excluded		6506	809	12.4% recovery overall

\*100 or more releases in a season.

*Long distance flights*

The 28 long distance flights recorded above are here treated in detail as they are considered the most important concerning movement of Monarch butterflies about New Zealand. Information on these flights, which only occurred in the North Island, is given in Table 3 and flight direction lines are shown in Fig. 3.

In cases where the butterfly plus tag or the tag alone were returned, and these are held in the Museum, the reports are considered as confirmed and are so noted in the Table. Those tag numbers received by letter or in record lists and by verbal advice are considered as unconfirmed. For the most part all these records are accepted but two unconfirmed records are considered doubtful and are noted as doubted in the Table.

Table 2. Numbers of Monarch butterflies recovered at various distances from three release sites.

Site (Co-operators)	Season	Distances (km)									
		0	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-50	> 50
Howick (K.S.A.)	1967-68	4	10	2	1			1			1
	1968-69	10	18	3	3						1
	1969-70	1	21	6	2			1			
	1970-71	2	21	6	5	2		4			1
	1971-72	14	30	14				2	2		
Napier (S.R.)	1968-69	4	29	9					1		
	1969-70		31	23	4			1	2		1
	1970-71		2	3	2						
Whangarei (C.W.) (Whau Valley)	1968-69		1				1				
	1969-70	7	17	32	9	4	4				3
	1970-71	19	32	26	10	5	3	4	4	7	1
	1971-72	4	20	11	7	2	2	1		2	3
	1972-73		6		1			1			
	1973-74		1	2	1						

The unconfirmed records are as follows.

- 9/1913 appears to be a flight southward, in autumn, out of an overwintering colony (Tauranga Bay). As such it would be the only ex-colony long flight (192 km) recorded in this study and seems unlikely, particularly at that time of year. The possibility of this being a transported individual also arises and is discussed below. This report is doubted although the presence of the butterfly is accepted as it was re-taken in the recovery area later the same month.
- 0/284 was carefully recorded 52 km south of the release point in Whangarei and this flight is accepted.
- 1/217 was a summer flight northward just over 20 km.
- 1/242 was another northward summer flight and, after re-release, there was a second capture in the same area, so it is accepted.
- 1/468 was recorded twice north of the release point in the same period as 1/217 and 1/473.
- 1/601 was sighted on two succeeding days by the same person at the same place. This individual was reported as 1/6001 but this number was not used. It is considered to be 1/601, released in Whangarei a month before, and thus represents a summer southward flight.
- 1/638 was taken away from the main south road and appears to be an acceptable summer southward flight.
- 2/221 apparently flew north from Whangarei to Hikurangi, as two separate sightings were reported by telephone advice, then south to Onerahi near the release area. This is a wandering summer flight.

Table 3. Long distance flights\* of Monarch butterflies.

Tag no.	Date released	Place released (Co-operator)	Sex	Reared or Transient	Date recovered	Place recovered	Alive or Dead	Recovery data <sup>†</sup>	Period (days)	Distance (km)	Direction	Status <sup>‡</sup>
9/1913	5.IV.69	Tauranga Bay (K.A.J.W.)	♂	T	12.V.69 25.V.69	Orewa Orewa	A	L LST	37 13	192.5 1	SSE	U-D C
0/223	18.I.70	Whangarei (C.W.)	♀	R	28.I.70	Kaitaia		LST	10	115	WNW	C
0/279	23.I.70	Whangarei (C.W.)	♀	R	17.II.70	Orewa	A	LST	25	106	SSE	C
0/284	23.I.70	Whangarei (C.W.)	♀	R	11.II.70	Kaiwaka	A	L	19	52	SSE	U
0/643	22.II.70	Whangarei (W.P.) (Maunu)	♀	T	2.III.70	Titirangi	A	ST	8	135	SSE	C
1/144	27.I.71	Whangarei (W.P.) (Maunu)	♀	T	8.II.71	Tangiteroria		LST	12	21.3	WSW	C
1/212	20.I.71	Whangarei (C.W.)	♀	R	8.II.71	Paparoa		LST	19	45	S	C
1/217	20.I.71	Whangarei (C.W.)	♀	R	8.II.71	Hukerenui	A	V	19	21	NNW	U
1/242	22.I.71	Whangarei (C.W.)	♀	T	29.I.71	Bland Bay	A	L	7	39.5	N	U
					31.I.71	Ohinewai Bay		LST	2	7.5	SSW	C
1/468	30.I.71	Whangarei (C.W.)	♀	R	11.II.71	Hukerenui	A	L	12	21	NNW	U
					12.III.71	Paiaka		L	29	5	W	U
1/473	30.I.71	Whangarei (C.W.)	♀	R	10.III.71	Hukerenui		LST	39	21	NNW	C
1/481	30.I.71	Whangarei (C.W.)	♀	R	27.II.71	Motatau		LT	28	33	NW	C
1/601	31.I.71	Whangarei (C.W.)	♀	T	27.II.71	Matakohe	A	L	27	50	S	U
					28.II.71	Matakohe	A	L	1	0	-	U
1/638	8.II.71	Whangarei (C.W.)	♀	T	11.II.71	Waiwera	D	L	3	100	SSE	U
2/213	8.II.72	Whangarei (C.W.)	♀	R	21.II.72	Cable Bay	D	LST	13	107.5	NW	C
2/214	8.II.72	Whangarei (C.W.)	♀	R	16.III.72	Ruawai		LST	37	55	SSW	C
2/221	8.II.72	Whangarei (C.W.)	♀	R	24.II.72	Hikurangi	A	V	16	10.7	N	U
					24.II.72	Hikurangi	A	V	0	6.7	NNE	U
					2.III.72	Onerahi		LST	7	20.3	SSE	C
2/270	11.II.72	Whangarei (C.W.)	♀	T	21.II.72	Cable Bay	D	LST	10	107.5	NW	C
2/280	17.II.72	Whangarei (C.W.)	♀	R	4.III.72	Ohinewai Bay	A	L	16	35	N	U
3/68	10.III.73	Maungaturoto (M.E.W.)	♂	T	15.III.73	Kumeu	A	VST	5	78.5	S	C
9/1265	19.III.69	Auckland (M.B.) (Eilerslie)	♂		30.IV.69	Whangarei	A	L	42	140	NNW	U
68/1	24.II.68	Howick (K.S.A.)		T	4.III.68	Waihi	A	L	9	96	SE	U
9/2379	21.V.69	Howick (K.S.A.)	♀	R	2.VI.69	Tauranga Bay	A	L	12	234	NNW	U
1/377	1.II.71	Howick (K.S.A.)	♀	T	10.II.71	Te Aroha		LT	9	98	SE	C
3/121	27.II.73	Pyes Pa (B.H.B.)	♂	R	7.V.73	Akitio		LST	69	295	S	C
3/181	27.III.73	Pyes Pa (B.H.B.)	♀	R	31.III.73	Rotorua		LST	4	35	SSE	C
0/56	22.I.70	Napier (S.R.)	♂		17.II.70	Whangarei		L	26	465	NNW	U-D
68/372	9.IV.68	Waipawa (G.I.)	♀		12.V.68	Napier	D	LST	33	56	NE	C

\*More than 20 km. †ST — Specimen plus tag. T — Tag only. L — Letter or list. V — Verbal advice. ‡C — Confirmed. U — Unconfirmed. D — Doubtful.

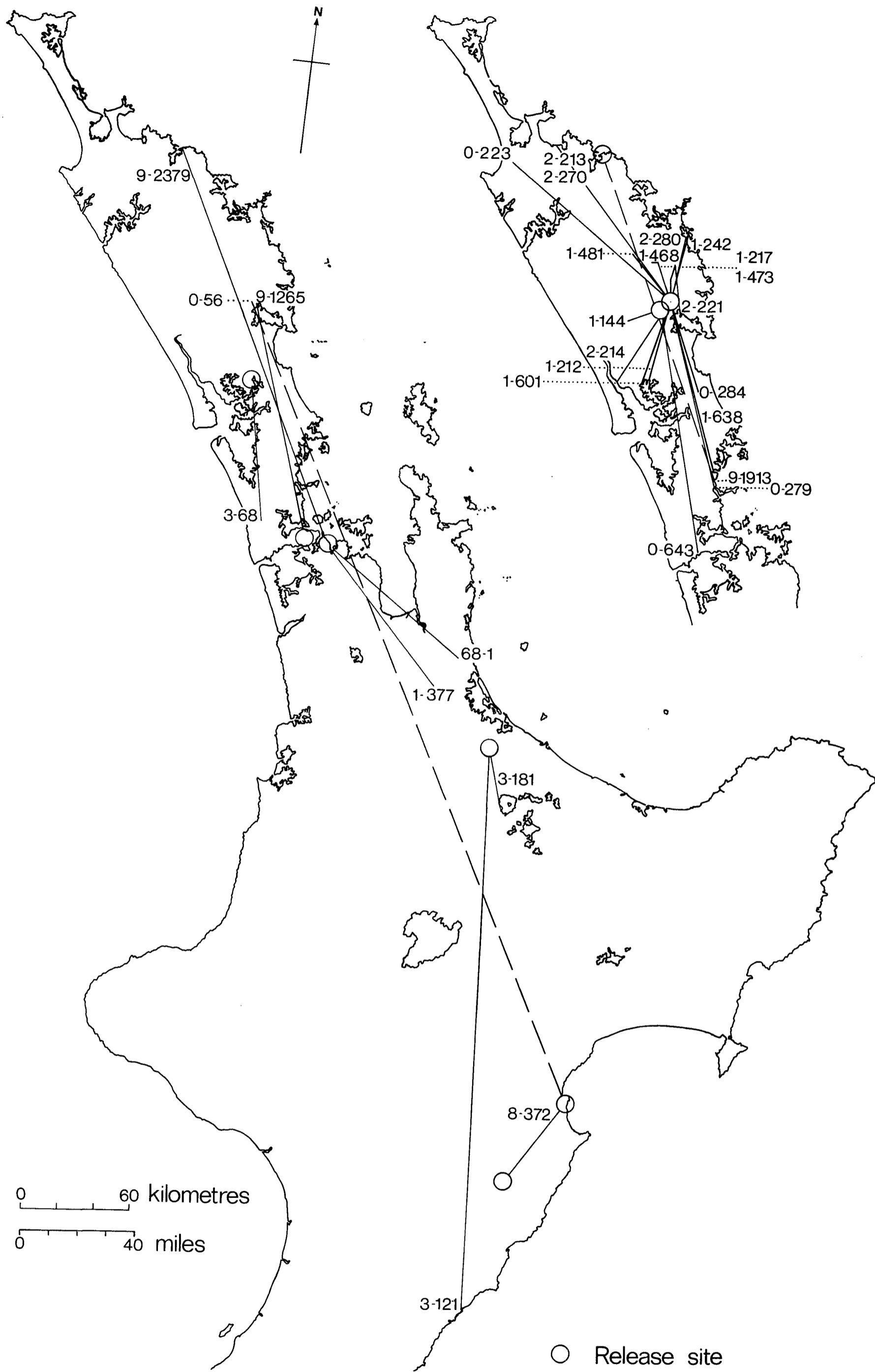


Fig. 3. North Island showing flight direction lines for recoveries of tagged Monarch butterflies over 20 km from release sites. The insert is used to separate flights within Northland from other flights. Numbers are tag numbers; broken lines are doubted flights.

- 2/280 was carefully recorded 35 km north of the release point and is accepted as a summer flight.
- 9/1265 was received alive at Whangarei Museum from a local person, and re-released. This is a northward flight from Auckland in late March-April and may be a pre-winter flight.
- 68/1 was the first release and apparently accomplished a good, long flight in 9 days before collection. The individual was kept for several days by a second person who checked the recovery and sent the advice.
- 9/2379 was noted at Tauranga Bay overwintering colony and re-released by one of a group there for tagging. If correct it was a late May (autumn-winter) flight from Howick and represents the only record of a movement into an overwintering colony.
- 0/56 was recorded and re-released in Whangarei at a time when similar numbers were in use there. For example, 0/156 was released within 2 km of the recovery site only a fortnight before. It would have been a very long summer flight northwards, from Napier, which is doubted.

As mentioned above, the only long flight originating from Tauranga Bay (9/1913), and the only one from an overwintering colony, may be invalid as it was tagged at a time when butterflies were entering the colony before the winter (5 April). It is further discussed below.

Of 18 long flights from Whangarei, 10 were northerly and 8 southerly. All were in the 'summer' period January to March, the latest date for a recovery being 16 March. In 1970, one flight (0/223) was 115 km WNW, another (0/279) 106 km S and a third (0/543) 135 km S, while in 1971, one (1/638) was 100 km S. In 1972, two individuals (2/213, 2/270) flew 107 km N. Being summer flights these are all quite possible and likely. Three flights around 50 km (0/284, 1/601, 2/214) were southerly and are accepted as are the remaining shorter flights over 20 km.

One long flight from Maungaturoto (3/68) was 78 km S, another March flight within the period and distance of the flights from Whangarei.

The one long flight recorded from Auckland (9/1265) was a late (March-April) northerly flight to Whangarei (140 km, NNW). Although unconfirmed this flight is complemented by a possible late northward flight (9/2379) from Howick, the same year.

Of the three long flights from Howick, two (68/1, 1/377) were just under 100 km in a south-easterly direction during the 'summer' period (February-March). The third (9/2379) is apparently a very late (May) flight to the northern overwintering colony. As such it represents the only recorded flight into an overwintering colony and would be classed as doubtful if it were not for a complementary late northward flight the previous month (9/1265, see above).

There were two long southerly flights from Pyes Pa although one (3/181), in March, was only 35 km. The other (3/121), however, was one of the longest flights recorded (295 km) and seems valid. It was in the February-May period and is interesting in that it possibly passed the Hastings overwintering colony.

The one long flight from Napier (0/56) was recorded in Whangarei (465 km, NNW) and this does not seem likely in view of the circumstances (see 0/56 above) and the fact that no others from this area were collected elsewhere.

The one long flight from Waipawa (8/372) was a confirmed late northerly flight (April-May, 56 km, NNE) which may not be unlikely. Interestingly, it would have passed the Hastings overwintering colony.

Of interest is the incidence of transient and reared butterflies amongst the 28 long flights, and also their sex. Of the males there were 2 transients (one a doubted flight from an overwintering colony), one reared and two unknown (that is, not recorded in either category by the marker) including one doubtful flight; of the females, 7 transients, 14 reared and one unknown; there was also one unsexed transient. Thus it is seen that the female Monarch butterflies made approximately 79% of the long flights and that twice as many reared females as transients were involved. These results indicate that reared as well as transient individuals do make long flights but it must be remembered that a butterfly recorded as transient by one person may have been reared by another and is not necessarily from a wild population.

As with other scientific projects there is occasionally the possibility of unwanted human intervention either intentional or unintentional. Within the present project the possibility of tagged individual Monarchs being carried and subsequently recorded as a long flight must be remembered. So far as the above recorded long flights are concerned most seem possible and reasonable. The only suspect in the present context is the one butterfly (9/1913) which was tagged in the northern overwintering colony and which was found a month later over 190 km away at a place on the main south road to Auckland. It seems very unlikely that a Monarch would leave an overwintering colony at that time of year (autumn-winter) and conversely it is the best time for visitors to the colony.

#### *Overwintering colonies*

A record of releases and recoveries of Monarch butterflies tagged in overwintering colonies is given in Table 4. Most individuals were re-recorded at the same place.

Table 4. Recoveries from releases of Monarch butterflies in overwintering colonies.

Centre (Co-operator)	Year	Released		Recovered		Distance (km)	
		No.	Time of year	No.	Time of year		
Tauranga Bay (K.A.J.W.)	1968	191	March-July	8	April-October	0	(6)
						0-1	(1)
						6-7	(1)
	1969	1634	April-June	176	April-September	0	(175)
						192	(1)
Hastings (S.R.)	1974	83	June	0	—	—	
	1969	40	April	11	April-October	0	(9)
						0-1	(1)
						1-2	(1)
Nelson (J.S.D.)	1968	50	June-August	7	June-December	0	(3)
						0-1	(3)
						11-12	(1)

Of the three overwintering colonies recorded by Ramsay (1964b), only the North Auckland colony in an isolated rural area at Tauranga Bay is known to the author. There, hundreds of Monarchs congregated on large pohutukawa trees (*Metrosideros excelsa* Sol.) above the sea-shore in the early years of the investigations. In later years it seemed that numbers were fewer. Only two individuals were recovered outside the site, one less than 7 km and the other a long distance flight which is doubted (see above). From personal observation and various reports, it is known that the colony site is empty in the summer. It is important to note that only a very few swan plants have been seen near the site during the present project and obviously the Monarchs do not continue to go there for breeding (see Ramsay 1964b:14); consequently they are more likely to be a migratory group. Only one butterfly tagged elsewhere was recorded in the northern colony; this unconfirmed flight is discussed above. While the colony is referred to here as being at one site (a small valley at the north end of the bay) other small overwintering groups were sometimes seen (and a few tagged) *ca.* 1 km away in the main valley.

The Hastings colony was sited on large conifer trees in Cornwall Park in the town. Even though tagging was done over several seasons in Napier, *ca.* 17 km away, no tagged butterflies from there or elsewhere were recovered in the Hastings colony. None tagged in the colony was taken more than 1.5 km away from it.

In Nelson, where Monarchs gathered on large conifers in the Queen's Gardens, only one individual was recorded as far as 11-12 km away, others no more than 1 km. None from outside was recovered in the colony. This must have been a relatively new group as Ramsay (1964b) recorded several groups on various trees at other sites but none at this site.

With the situation of the three known overwintering areas (Fig. 2) in New Zealand, being one in the north, one in the middle and one in the south, it was expected that somewhere butterflies would be found moving towards or into at least one of the colonies and would also be found leaving or spreading out from a colony. However, no such movements have been found even though the colonies break up by summer.

#### *Adult longevity and time of year*

In a note on the longevity of Monarch butterflies in Australia, Smithers (1973b) recorded adult life periods up to 26 weeks. During the present study, most Monarch butterflies were recaptured within two months; these were mainly 'summer' individuals. Others lived more than two months before recapture; of these, individuals definitely recorded as recovered alive are listed in Table 5. It is noteworthy that none of the listed butterflies made long flights unless they left and returned to the release areas which is unlikely as most were 'winter' individuals; some of them were taken near their home sites in each of the months from April to August.

The records in Table 5 indicate that some of the 'summer' individuals (tagged January, February) can live more than two months. Those tagged in March, April, May are also shown to live more than two months and as long as five months; it could be expected that these at least may survive over winter. Of those butterflies taken in July and August, almost all had already lived at least three months.

Table 5. Longevity\* and occurrence of Monarch butterflies.

Tag no.	Place released (Co-operator)	Date released	Reared or Transient	Sex	Date recovered	Place recovered	Distance (km)	Period (days)
2/115	Whangarei (C.W.)	31.I.72	R	♂	2.IV.72	Whangarei	0-1	62
0/1338	Howick (D.W.)	17.IV.70	R	♀	20.VI.70	Howick	0-1	64
3/1	Whangarei (C.W.)	23.II.73	T	♂	29.IV.73	Kamo	0-1	65
0/1048	Howick (K.S.A.)	11.III.70	R	♀	17.V.70	Howick	0-1	67
9/2868	Whangarei (S.L.)	24.V.69	T	♀	31.VII.69	Whangarei	0-1	68
2/519	Howick (K.S.A.)	23.II.72	R	♂	4.V.72	Howick	0-1	71
9/1701	Napier (S.R.)	9.IV.69	R	♀	29.VI.69	Napier	0-1	81
2/958	Howick (K.S.A.)	8.IV.72	R	♂	29.VI.72	Howick	0-1	82
0/292	Whangarei (C.W.)	24.I.70	R	♂	21.IV.70	Whangarei	4-5	87
1/287	Whangarei (C.W.)	26.I.71	T	♀	27.IV.71	Whangarei	5-6	91
9/1680	Howick (K.S.A.)	29.IV.69	R	♂	29.VII.69	Howick	0-1	91
9/2858	Whangarei (S.L.)	13.V.69	T	♂	18.VIII.69	Whangarei	0-1	97
1/170	Napier (S.R.)	6.IV.71	T	♀	19.VII.71	Napier	1-2	104
0/514	Whangarei (C.W.)	21.III.70	R	♂	9.VII.70	Whangarei	1-2	110
9/1284	Auckland Ellerslie (M.B.)	8.IV.69	T	♀	3.VIII.69	One Tree Hill	1-2	117
8/43	Howick (K.S.A.)	28.III.68	R	♂	28.VII.68	Howick	0-2	122
9/1664	Howick (K.S.A.)	24.IV.69	R	♀	26.VIII.69	Howick	2-3	124
0/799	Napier (S.R.)	26.II.70	R	♂	1.VII.70	Napier	1-2	125
1/874	Napier (P.D.)	28.III.71	T	♂	27.VIII.71	Napier	0-1	152
9/1328	Napier (S.R.)	13.III.69	T	♀	18.VIII.69	Napier	1-2	158

\*More than two months.

The results in Table 5 also confirm the presence of active 'winter' Monarchs (recovered June-August) from Whangarei in the north to Napier in the south, none of which was captured more than 3 km from its release site, and most within 2 km.

#### DISPERSAL INFORMATION

During the period of the project other information came to hand.

Mr R.B. Sibson, Ornithologist, of Auckland, advised in April, 1970, that Monarch butterflies were drifting northwards over the Kaipara Harbour, north of Auckland on the west coast, on 29 March, 1970, a fine day with a light southerly wind.

The late Dr R.A. Falla, Director and Ornithologist, Dominion Museum, Wellington, advised the author in April, 1970, of the sightings of an observer known to him; in the Kaimanawa Ranges, west of Napier, streams of Monarchs were flying westward against light westerly winds, in the middle of the day, on two or more days in February, 1970.

From Napier, itself, a report sent on 23 May, 1972, was of Monarchs swarming on willows, up to 50 on a branch, at that time. Whether this was a moving group or the beginning of an overwintering group is not recorded.

Concerning records in the South Island, apart from Nelson, there are reports of Monarchs at Gore Bay, south of Kaikoura on the east coast, and in Christchurch. A further report dated 8 April, 1968, was of a Monarch visiting swan plant earlier that season at Mt Pleasant, Christchurch, with subsequent larvae on the plant and, later, butterflies emerging. Two Monarch butterflies were reported in June, 1968, as flying near Waikouiti, north of Dunedin, the previous summer.

From Invercargill, Dr R. Burns Watson advised in June, 1968, of a Monarch butterfly flying in a garden at Riverton Rocks (southern coast) on 15 April, 1967, and another in the same garden on 22 April, 1968. A subsequent newspaper article in Invercargill brought reports of sightings of Monarchs at Colac Bay, Bluff and Invercargill in January-May, 1968, all on or near the southern coast of the South Island.

Some of this information indicates that mass movements of Monarch butterflies may occur at times in New Zealand. The remainder confirms that the species can disperse throughout the length of the country, at least as far as the southern coast of the South Island.

#### OVERWINTERING

From time to time during the project Monarchs flying in the 'winter' period were seen by the author and were reported by other observers. The inference is that these individuals and others (see above, Table 5 and comments) are able to fly on warm, sunny days at any time during the colder part of the year, although they may be expected not to fly far. For example, two such butterflies were recorded in Whangarei, one tagged on 5 July, 1969, was re-taken at the same place on 19 July, and the other tagged in September, 1970, was recovered at the same place in October.

In Auckland the author has received many reports of 'winter' Monarch butterflies over the years and several, in particular, of small groups in large trees in the city and suburbs, to the south (Papatoetoe) and to the north on the North Shore side of the harbour, as well as in Howick to the east.

These 'winter' occurrences are in accord with the lack of evidence of movements into and out of overwintering colonies. It appears that, at least in the North Island of New Zealand, many Monarchs are not obliged to move into overwintering colonies separate from summer breeding areas. They are capable of overwintering solitarily or in small groups within the breeding areas and, consequently, are available to provide breeding populations for the next season.

#### DISCUSSION

Although in the early 1970s the project was receiving much assistance and many recoveries were being made, it became obvious that results indicating dispersal or general movements of Monarch butterflies in New Zealand were negligible. Recorded movements across country were few and movements into and out of overwintering colonies had not been traced. In fact, despite several years of work, the project had been singularly unsuccessful. It seemed that tagging (mostly home-reared individuals) and recovery were not enough. A much wider project would be needed, involving the search for butterflies on uni-directional flights and in other congregations both summer and winter, for possible food-plant escapes and consequent wild larval populations and for other sources of adults (? immigrants). In view of the difficulties of widening the scope of the project at that time, and the feeling that any further work on the same lines would involve co-operators in much activity without the prospect of better results, it was decided not to continue.

The project did not produce the information sought on dispersal of Monarch butterflies; no large scale migrations or movements were detected by tagging. The project had, in the main, established that large numbers of Monarch butterflies in the North Island stayed in their home areas both in summer and winter periods, although a small number did make long flights. At the same time the presence of known overwintering colonies was confirmed, particularly one at Tauranga Bay in the far north, but no movements into or out of these were recorded. By the end of the project the author had recognised that the regular seasonal situation for Monarch butterflies in North America did not hold in New Zealand. It appears that in this country there were some Monarchs which moved and some which did not.

#### CONCLUSION

Since results from tagging and from observation of Monarch butterflies in Australia have been published, the situation in New Zealand can be better compared. Smithers (1965) had remarked that the behaviour pattern of Monarch butterflies in southern Australia was different from that in North America and he later recorded (1972) overwintering clusters and breeding populations close to each other, south of Sydney. Smithers (1977) has subsequently shown that Monarch butterflies occur in both the north and south of eastern Australia in the summer and do not entirely leave the south in the winter (in the latitudes of Sydney, Adelaide and the far north of New Zealand). Detailed observations of individuals and colonies have been made more recently by James who has also recorded

and discussed adjacent overwintering clusters and breeding populations in the Sydney area (James 1979). Thus it appears that both in Australia and New Zealand some Monarch butterflies are in moving groups and others remain in one place.

In contrast to Australia, a continent with wide topographic variations reaching from a temperate zone into the tropics, New Zealand is isolated, insular and elongate, orientated in a more or less north-south line and reaching from warm temperate to cold temperate climates. For these reasons it may be more difficult to gather information on Monarch movements in this country and there is still need for further research in an extended but planned and controlled programme. Observations on individual butterflies, such as those made by Smithers and James, and started by Ramsay in New Zealand, are still also needed.

Contrary to those who have postulated west-east flights of insects between Australia and New Zealand, it has long been the author's contention that, because of the circular weather systems moving across (west to east) or through (south-west to north-east) the Tasman Sea area, semicircular, arcuate or sinuous paths are probable for wind-borne insects, with the added possibility of return flights or separate movements from New Zealand to Australia. Is it possible that Monarch butterflies in the northern overwintering colony, for example, might arrive from overseas and might also attempt a return flight?

It is hoped that, in the future, further tagging, trapping and observation, or more sophisticated marking-recovery procedures, will elucidate the trans-Tasman insect flows and the situation concerning movements within New Zealand.

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