Invasive Ant Risk Assessment

Tapinoma melanocephalum

Harris, R.

(A) PEST INFORMATION

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A1. Classification

Family:	Formicidae
Subfamily:	Dolichoderinae
Tribe:	Dolichoderini
Genus:	*Tapinoma*
Species:	*melanocephalum*

A2. Common names

Ghost ant (Naumann 1993).

Also known as: tramp ant, black-headed ant, tiny yellow house ant, house infesting ant (Harada 1990), Awate-konuka-ari (Japan) (www39), albaricoque (Puerto Rico) (Smith 1965), hormiga bottegaria (Cuba) (Smith 1965).

A3. Original name

Formica melanocephala Fabricius.

A4. Synonyms or changes in combination or taxonomy

Myrmica pellucida Smith, *Formica nana* Jerdon, *Formica familiaris* Smith, *Tapinoma (Micromyrma) melanocephalum* var. *australis* Santschi, *Tapinoma (Micromyrma) melanocephalum* var. *australe* Santschi.

Current subspecies: nominal plus *Tapinoma melanocephalum* var. *coronatum* Forel, *Tapinoma melanocephalum* var. *malesianum* Forel.

A5. General description (worker)

Identification

Size: monomorphic. Total length around 1.5 mm, ranging between 1.3 and 1.9 mm.

Colour: distinctively bicoloured (Fig. 1): head (including antennae, except for first 2 segments), and sides of alitrunk blackish-brown; dorsal alitrunk (except propodeum) and legs pale yellow. Gaster mostly pale, sometimes with brown patches.

Surface sculpture: head and body mostly with fine sculpture, appearing slightly dull.

General description: antennae 12-segmented. First antennal segment (scape) long, surpassing the posterior border of head. Eyes large, with 9–10 ommatidia in the longest row. Mandibles each with 3 large teeth and about 7 small denticles, and with the surface containing the teeth and that near the clypeus rounding gradually into one another (basal angle absent). Clypeus without longitudinal carinae, anterior margin slightly concave in the alitrunk in profile almost smoothly convex, with slight metanotal depression. Propodeum without spines, the upper surface shorter than the rear surface. One rudimentary node (petiole) present, which lacks a distinct forward face and is partially or completely concealed (viewed from above) by forward projection of the first segment of the gaster. Gaster with 4 segments on its upper surface. Dense fine pubescence all over, erect setae on clypeus and gastral apex only. Stinger and acidopore absent.

Tapinoma / Technomyrmex separation: in *Tapinoma*, there are four segments on the upper surface of the gaster, while in *Technomyrmex* the gaster has 5 segments on its upper surface (although the fifth may be small and retracted in some specimens). In addition, *Technomyrmex* workers are generally larger than *Tapinoma* workers and are black rather than brown.

Sources: Passera 1994; www39; www36.

In urban areas this ant is commonly confused with *Monomorium pharaonis* (Pharaoh ant), which is another common household ant and similar in size. However, ghost ants have a distinctively lighter abdomen than thorax and head, and the Pharaoh ant has a darker abdomen than its thorax and head. Also, unlike *Tapinoma*, *M. pharaonis* has a post-petiole but this would be difficult to see without magnification.

a)

b)

Fig. 1: Images of Tapinoma melanocephalum*; a) dorsal view of workers with a penny for scale, b) dorsal view of workers (Source: S.D. Porter, USDA-ARS).*

A6. Behavioural and biological characteristics

A6.1 Feeding and foraging

Tapinoma melanocephalum foragers are opportunists (Andersen & Reichel 1994). Workers have the habit of running rapidly and erratically, and omit a distinctive odour like rotten coconuts when disturbed (Smith 1965). Sometimes they are seen trailing, where movement is more slow and deliberate, and in such cases some workers will likely be carrying brood (wwwnew45). They forage on many household foods, especially sweet foods, and in hot climates and glasshouses tend honeydew-excreting insects. They also feed on dead and live insects (Smith 1965) and root scales (Smith 1936, cited in Fowler et al. 1990). Foragers locate and recruit to food rapidly in numbers (Lee 2002); Clark et al. (1982) often recorded 33-64 foragers at small baits before they were displaced when dominant ants (e.g., *Wasmannia auropunctata*) recruited to food in larger numbers. Clark et al. (1982) found that *T. melanocephalum* was frequently the only ant present on sugar water baits, but also the species most often replaced, suggesting a “rapid utilization” foraging strategy.

A6.2 Colony characteristics

Tapinoma melanocephalum have polygyne, unicolonial, colonies that can build up large numbers (Smith 1965), with individual nests containing 100–1000 individuals (Harada 1990). Generally, the colonies occupy several local sites that are too small or unstable to support the entire colony, and nests readily exchange workers along odour trails (wwwnew45). There does not appear to be any infighting between members of different colonies or nests, at least when they originate from the same area (Bustos & Cherix 1998; wwwnew45). Colonies are almost always in disturbed areas and in and around buildings in Florida (Deyrup et al. 2000). They often occupy temporary habitats (plant stems, clumps of dried grass, debris) and readily migrate if disturbed or conditions become unfavourable (Passera 1994). Queens have a very short lifespan of only a few weeks (Harada 1990, cited in Passera 1994 [but information in Harada (1990) refers to *T. sessile*]). In tropical environments they will primarily nest outdoors, in small protected areas such as in and under potted plants, in dead tree limbs, under stones, in palm fronds, and in organic debris (Appel et al. 2004).

A7. Pest significance and description of range of impacts

A7.1 Natural environment

Tapinoma melanocephalum appears to be a disturbance specialist and in many locations is absent from undisturbed natural habitat (e.g., Florida (Deyrup et al. 2000); Brazil (Fowler et al. 1994)). Where it does occur in natural or semi natural disturbed vegetation or remnants it appears to be a minor component of the community and is never numerically or behaviourally dominant (e.g., small monsoon vine forest remnant (Andersen & Reichel 1994), forest litter in American Samoa dominated numerically by *Odontomachus simillimus* or *Anoplolepis gracilipes* (Vargo 2000), litter in Puerto Rico dominated numerically by *Wasmannia auropunctata*, *Solenopsis corticalis,* and *Strumigenys rogeri* (Barberena-Arias & Aide 2003), Philippine rice fields (Way et al. 1998), Nukunonu Island, Tokelau, dominated numerically by *A. gracilipes* or *Paratrechina longicornis* (Lester & Tavite 2004), a Brazilian Pepper stand in everglades national park, Florida (Clouse 1999), and secondary rain forest in Cameroon (Dejean et al. 1994)).

Tapinoma melanocephalum was not mentioned in Holway et al.’s (2002a) review of invasive ants. Reviews of pest ants in North America by Smith (1965), Thompson (1990), and Deyrup et al. (2000) include this species as a pest, but only in relation to urban areas.

Tapinoma melanocephalum is unlikely to displace other ant species in natural environments. Banana plantations in Sao Paulo Brazil with *T. melanocephalum* present had less other ant species than those without *T. melanocephalum* (2 ± 0.5 compared to 13 ± 4.3) (Fowler et al. 1994), but it was probably different management practices that allowed *T. melanocephalum* to establish at some orchards rather than this species eliminating other ant species. *Tapinoma melanocephalum* is a rapid coloniser and may benefit from control of other invasive ant species (Lee 2002).

Tapinoma melanocephalum has been recorded tending a myrmecophilous butterfly of the genus *Zizeeria* (Warnecke 1932/33, cited in Fiedler & Hagemann 1992).

A7.2 Horticulture

Tapinoma melanocephalum tends honeydew producing homopterans (Appel et al. 2004), including root scales (Smith 1936, cited in Fowler et al. 1990) and fruit scales on bananas (Fowler et al. 1990). In Cuba, they are known to disperse a grass root mealybug on the roots of sugarcane (Smith 1965). No reports were found of it being considered a significant pest of horticulture.

Countering the tending of honeydew-producing homopterans may be its role as a predator of other pest and disease spreading species. Foragers were observed carrying off diamondback moth larvae in India (Chelliah & Srinivasan 1986), preying on a disease spreading bug in Venezuela (Gomez-Nunez 1971), and destroying eggs and larvae of houseflies in Puerto Rico (Pimental 1955, cited in Smith 1965). Osborne et al. (1995) found that *T. melanocephalum* was a significant predator of two-spotted spider mites (*Tetranychus urticae*) and aphids in glasshouses in Florida, and they fed on western flower thrips and *Ecinothrips americanus* when aphids or mites were not present. They also feed on flea eggs and larvae (Tamsitt & Fox 1966).

As a predator *T. melanocephalum* can be a pest of insectaries (Smith 1936, cited in Harada 1990). At the Florida Department of Agriculture in Gainesville, the ant preyed on small beetle larvae and lepidopterous larvae from the insect cultures in quarantine (Nickerson & Bloomcamp 1988, cited in Osborne et al. 1995).

A7.3 Human impacts

Tapinoma melanocephalum is a significant urban pest capable of infesting residential kitchens and commercial food outlets in large numbers (Lee 2002). It can enter buildings through screens and small cracks and be a general annoyance (Deyrup et al. 2000). It is almost invisible apart from its head which is seen as a black, fast moving dot (Collingwood et al. 1997). Sometimes it forms wide, loose columns on walls. Some people suffer slight, red irritation of the skin following contact with this ant (Collingwood et al. 1997). In Florida it is considered one of the most important house infesting pests and complaints to pest controllers regarding *T. melanocephalum* were primarily due to it being a general nuisance (80%) or infesting food (15%) (Klotz et al. 1995). In southern Bahia, Brazil, a study of the ant community infesting houses found *Pheidole megacephala* and *T. melanocephalum* to be the most common of 31 ant species infesting houses (Delabie et al. 1995). It was also one of three common species in southeastern Brazil, with *M. pharaonis* and a native species of *Crematogaster* (Fowler & Bueno 1995). In Honolulu, *T. melanocephalum* was reported as a common household pest in the 1940s, but was seldom collected during the 1950s (Clagg 1957). No reports were found of it damaging wiring or any other structures within buildings.

Tapinoma melanocephalum may also have a role in disease transmission. It is abundant in hospitals in South America, and capable of transporting pathogenic microbes including seven types of bacteria, such as *Enterobacter cloacae* (Jordan) and *Staphylococcus* sp. (Olaya & Chacon 2001, cited in Ulloa-Chacon & Jaramillo 2003; Fowler et al. 1993). It has also been recorded on decaying rabbit carcasses in India (Bharti & Singh 2003).

On the positive side, *T. melanocephalum* was found to be the primary predator of the eggs of *Rhodnius prolixus*, the vector of Chagas' disease in coastal Venezuela (Gomez-Nunez 1971). Chagas' disease is caused by *Trypanosoma cruzi* and is a serious public health problem in Latin America (Gutierrez et al. 2003). This predation on *R. prolixus* populations by *T. melanocephalum* may account for the absence of *R. prolixus* associated diseases from this area of Venezuela (Gomez-Nunez 1971).

A8. Global distribution

A8.1 Native range

Tapinoma melanocephalum originates from the old world tropics (Deyrup et al. 2000), but it has spread so widely that is unclear if its native range is Asia or Africa (Wilson & Taylor 1967). Until molecular phylogenies are constructed, ecological and historical information remains insufficient to establish its origins. Its range has probably spread within its native continent due to urbanisation and reduced competition with other native ant species in anthropogenic habitats

A8.2 Introduced range

This prominent tramp species has become widely distributed in the tropical and subtropical zones of the world (Fig. 2), often in close association with human settlement (e.g., in monsoonal Australia (Andersen 2000)). It also is recorded from a number of temperate locations where it is present (either temporarily or permanently) in heated buildings (e.g., Germany (Steinbrink 1987), Canada (Francoeur 1977), and Finland (Sorvari 2002)).

A8.3 History of spread

Tapinoma melanocephalum is a common tramp species frequently intercepted and spread with trade for well over a century. It was first recorded in Florida in 1930 and is now common from south Florida north to Volusia County (about latitude 29°12' N) (Deyrup et al. 2000). The ant was first reported in Texas in 1994, in a tropical rainforest exhibit in Galveston (Cook et al. 1994). It probably arrived on a shipment of plants from Florida (Cook et al. 1994) and no further records have been reported confirming its spread to other counties. It has been found in several other locations in North America in association with heated buildings, the earliest record found being one from the state of Virginia in 1933 (wwwnew54).

A.9 Habitat range

Tapinoma melanocephalum appears highly flexible in the habitats occupies, providing there is some form of disturbance allowing it to establish ahead of behaviourally dominant species. It frequently nests in unstable and temporary habitats such as plant stems, clumps of dry grass, or other debris (Passera 1994). It has been sampled nesting at ground level and arboreally. In temperate regions it is only associated with greenhouses and heated buildings (Smith 1965; Francoeur 1977).

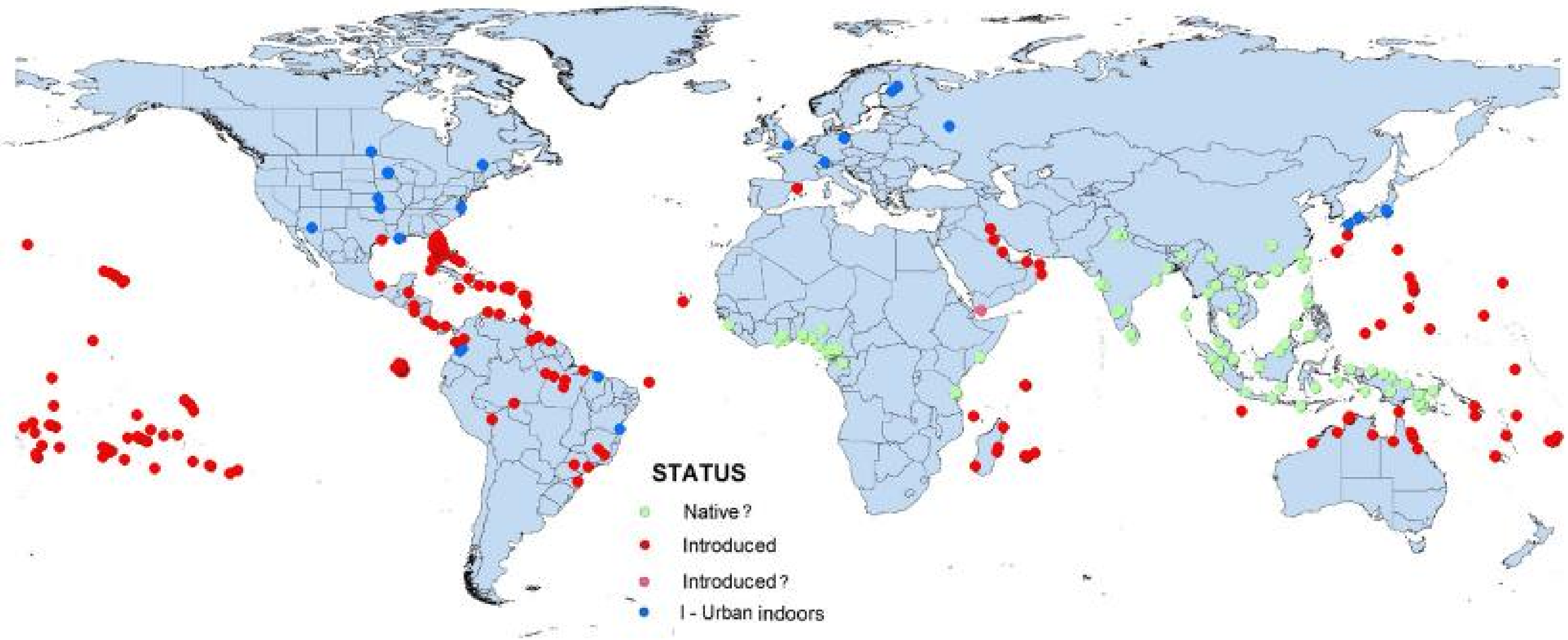

Fig. 2: *Global distribution of* Tapinoma melanocephalum. *Data from Landcare Research Invasive Ant Database as at January 2005. It remains unclear if Africa or Asia represents the original native range. The blue urban records are those where the ant was reported to be restricted to within buildings.*

(B) LIKELIHOOD OF ENTRY

B1. Identification of potential pathways

Because of the small size of *T. melanocephalum* and its ability to nest in a variety of materials (e.g., potted plants, cut flowers, and luggage), it can easily be transported from one location to another (Appel et al. 2004). Colonies have been found in a wide variety of situations, including cupboards, instrument case lining, piles of discarded clothing (Harada 1990), meaning that the ant is likely to be associated with a wide variety of freight types.

Tapinoma melanocephalum was intercepted at the New Zealand border 51 times between 1997 and the end of 2002. A directive to identify all ants intercepted at New Zealand ports during 2003 and into March 2004 has resulted in a further 36 interceptions at the border (MAF records). Interceptions range from fresh produce to electronic equipment (MAF interception records). However, the most prevalent pathways for this ant appear to be fresh produce (53%) and personal effects (17%), with the Pacific (75%), particularly Fiji and Tonga, being the predominant origin of interceptions (Table 1 & 2). 7% of interceptions from known locations are from Singapore and all of those are since the end of 2002. Interceptions from air freight (> 39%) and associated with air passengers (> 29%) are particularly common for this ant. No interceptions have been reported in association with empty containers, unlike some of the tramp ants (e.g., *Anoplolepis gracilipes, Paratrechina longicornis,* and *Solenopsis geminata*). About 90% of the interceptions have been at Auckland (seaport and airport), with Wellington (seaport and airport) (5%) the only other location to have more than a single interception.

Interceptions are mostly of workers, with only one queen (on fresh coconuts from Tonga) and one nest (lighting equipment air freighted from Fiji) being intercepted. A nest, of unknown origin, was found on the Ports of Auckland wharf in summer 2002–2003 (Ormsby 2003).

In Australia, air cargo (29%) and personal effects of air passengers (61%) are an even more significant component of total interceptions than they are in New Zealand. Fresh produce and cut flowers are common hosts outside of personal effects (Tables 3). Interceptions in Australia most commonly originate from Singapore (25%) and Indonesia (21%) rather than the pacific, although Fiji is well represented (11%) (Table 4).

Nineteen interceptions from Hawaii (6 of which are internal interceptions) are predominantly associated with plants and cut flowers (74%) and list only a single record as baggage (data from January 1995 to May 2004; Source: Hawaii Department of Agriculture). These records list the USA (the states of California, Florida, and Kentucky), Philippines and Guatemala as origins that are not recorded in the Australia and New Zealand data.

For several of the reported origins of interceptions of *T. melanocephalum* at the New Zealand, Hawaiian and Australian borders (Chile, Guatemala, East Timor, and the US states of Kentucky and California) the Landcare Research Invasive Ant Database does not currently have records of the ants presence. If these origins are correct (and not freight documentation errors or ants picked up in transit), this would further increase the risk pathways to New Zealand.

B2. Association with the pathway

Tapinoma melanocephalum is well established across the Pacific region and throughout much of the tropics. Large amounts of trade come o New Zealand from areas of the Pacific Region where this ant is present. It is a common associate with urban areas and buildings, which explains the high number of interceptions at the New Zealand and Australia borders in personal effects. Interceptions showing its association with a wide range of commodities (especially in personal effects) suggest it is usually a stowaway, rather than having host-specific associations. Targeting of search effort towards personal effects coming into New Zealand (and Australia) from the Pacific may account for the high interception rate of *T. melanocephalum* via that particular pathway. However, as *P. longicornis*, *S. geminata* and *W. auropunctata* are also commonly intercepted entering Australia in personal effects, this particular pathways warrants targeting. Fresh produce and cut flowers from Singapore are another pathway that appears to be commonly associated with *T. melanocephalum* contamination, and could be specifically targeted. Singapore is also a common location for containers to be offloaded in transit, and the risk of *T. melanocephalum*, and other ants, gaining entry to containers at this location may be worth investigation.

B3. Summary of pathways

A summary of freight coming to New Zealand from localities within 100 km of known sites of *T. melanocephalum* infestation is presented in figure 3 (also see Appendix 1). Total volumes of freight from localities with this ants nearby during 2001–2003 were moderately high representing about 15% of total air freight and 16.4% of sea freight (20.1% of sea freight where country of origin was reported).

Table 1: Commodities from which *T. melanocephalum* has been intercepted on at the New Zealand border.

Freight type	1997-2002	2003-2004
Container [a]	2	7
Cut flowers	5	4
Fresh produce	31	15
Personal effects	9	6
Incursion	0	2
Timber	1	0
Plants	1	0
Miscellaneous	2	2

[a] none recorded as empty

Table 2: Reported origin of New Zealand border interceptions of *T. melanocephalum*.

Country	1997-2002	2003-2004
Australia	2	1
Chile	1	0
Cook Islands	2	2
Fiji	14	12
French Polynesia	0	1
Hong Kong	1	0
Indonesia	1	3
Malaysia	1	0
Niue	1	0
PNG	0	1
Samoa	3	2
Singapore	0	6
Thailand	2	0
Tonga	20	5
Unknown	2	2
Vietnam	1	0
Wallis and Futuna Islands	0	1

Table 3: Commodities from which *T. melanocephalum* has been intercepted at the Australian border. Data from January 1986 to 30 June 2003 (Source: Department of Agriculture, Fisheries and Forestry, Canberra).

Freight type	No
Container [a]	2
Cut flowers	3
Fresh produce	6
Incursion in airport	1
Miscellaneous	1
Personal effects	23
Ships stores	1
Wood products	1

neither recorded as empty[a]

Table 4: Reported origin of Australian border interceptions of *T. melanocephalum*. Data from January 1986 to 30 June 2003 (Source: Department of Agriculture, Fisheries and Forestry, Canberra).

Country	No.
East Timor	1
Fiji	4
Indonesia	8
Malaysia	4
New Caledonia	1
Philippines	1
Ship	1
Singapore	9
Sri Lanka	2
Thailand	3
Unknown	1
USA	1
Vietnam	1

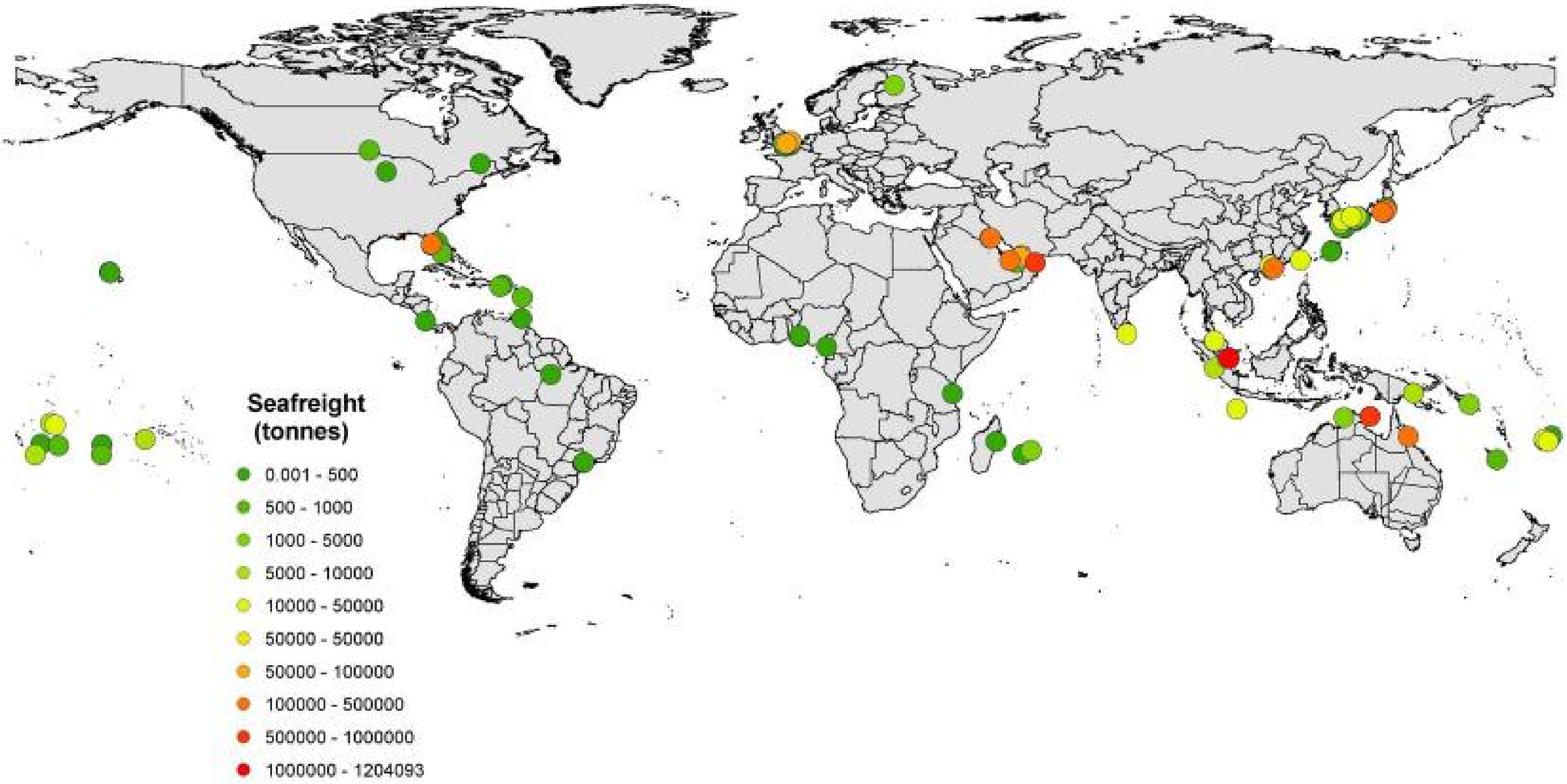

Fig. 3a: *Summary of sea freight coming to New Zealand from localities within 100 km of known sites with* T. melanocephalum. *Values represent the total freight (tonnes) during 2001, 2002 and 2003 (source: Statistics New Zealand). Details of locations and a breakdown of commodities types are given in Appendix 1.*

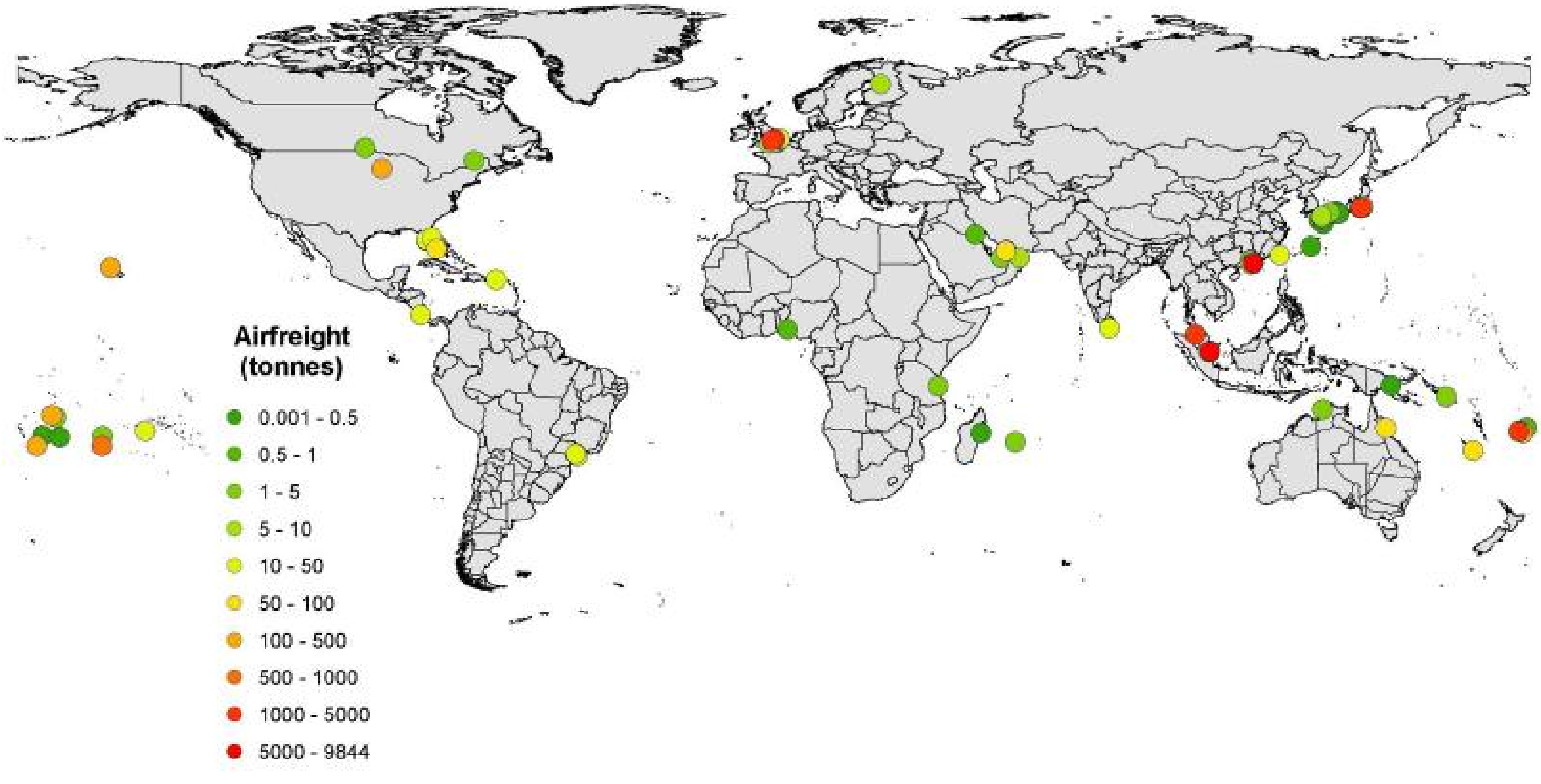

Fig. 3b: *Summary of air freight coming to New Zealand from localities within 100 km of known sites with* T. melanocephalum. *Values represent the total freight (tonnes) during 2001, 2002 and 2003 (source: Statistics New Zealand). Details of locations and a breakdown of commodities types are given in Appendix 1.*

(C) LIKELIHOOD OF ESTABLISHMENT

C1. Climatic suitability of regions within New Zealand for the establishment of the ant species

The aim of this section is to compare the similarity of the New Zealand climate to the locations where the ant is native or introduced using the risk assessment tool BIOSECURE (see Appendix 2 for more detail). The predictions are compared with two species already established in New Zealand (*Ph. megacephala* and *L. humile*) (Appendix 3). In addition a summary climate risk map for New Zealand is presented; this combines climate layers that most closely approximate those generated by the risk assessment tool Climex.

C1.1 Climate limitations to ants

Given the depauperate ant fauna of New Zealand (only 11 native species), and the success of many invasive ants throughout the world in locations with diverse ant faunas (e.g., Human & Gordon 1996), competition with New Zealand native ant species is unlikely to be a major factor restricting the establishment of invasive ants in New Zealand, although competition may be important in native forest where native ant abundance and diversity is higher (R. Harris, pers. obs.). For some species, the presence of other adventive ants in human modified environments could limit their distribution (e.g., *Solenopsis invicta* has severely restricted the distribution of *S. richteri* and *L. humile* within the USA (Hung & Vinson 1978; Porter et al. 1988)) or reduce their chances of establishment. However, in most cases the main factors influencing establishment in New Zealand, should queens or colonies arrive here, are likely to be climatic.

A significant relationship between maximum (and mean) daily temperature and foraging activity for both dominant and subordinate ants species indicated temperature rather than interspecific competition primarily determined the temporal activity of ant communities in open Mediterranean habitats (Cerda et al. 1998). Subordinates were active over a wider range of temperatures (Cerda et al. 1998). In California *L. humile* foraging activity was restricted by temperature, with maximum abundance at bait at 34°C, and bait abandoned at 41.6°C (Holway et al. 2002b).

Temperature generally controls ant colony metabolism and activity, and extremes of temperature may kill adults or whole colonies (Korzukhin et al. 2001). Oviposition rates may be slow and not occur at cooler temperatures (e.g., *L. humile* does not lay eggs below a daily mean air temperature of 18.3°C (Newell & Barber (1913) quoted in Vega & Rust 2001)). At the local scale, queens may select warmer sites to nest (Chen et al. 2002).

Environments with high rainfall reduce foraging time and may reduce the probability of establishment (Cole et al. 1992; Vega & Rust 2001). High rainfall also contributes to low soil temperatures. In high rainfall areas, it may not necessarily be rainfall per se that limits distribution but the permeability of the soil and the availability of relatively dry areas for nests (Chen et al. 2002). Conversely, in arid climates, a lack of water probably restricts the ant distribution, for example *L. humile* (Ward 1987; Van Schagen et al. 1993; Kennedy 1998) although the species survives in some arid locations due to anthropogenic influences or the presence of standing water (e.g., United Arab Emirates (Collingwood et al. 1997) and Arizona (Suarez et al. 2001)).

New Zealand has a cool temperate climate and most non native ant species established here have restricted northern distributions, with most of the lower South Island containing only native species (see distribution maps in New Zealand information sheets (wwwnew83)). Few adventive species currently established in New Zealand have been collected outside urban areas in the cooler lower North Island and upper South Island (R. Harris, unpubl. data); for some this could reflect a lack of sampling, but the pattern generally reflects climatic limitations. In urban areas, temperatures are elevated compared with non-urban sites due to the warming effects of buildings and large areas of concrete, the "Urban Heat Island" effect (Changnon 1999). In addition, thermo-regulated habitats within urban areas (e.g., buildings) may allow ants to avoid outdoor temperature extremes by foraging indoors when temperatures are too hot or cold (Gordon et al. 2001).

C1.2 Specific information on T. melanocephalum

Very limited information is available relating to temperature tolerances of *T. melanocephalum*. Appel et al. (2004) investigated laboratory tolerances of workers maintained at temperature ranging from 15–45°C and a range of humidites. They found low mortality at 15°C whatever the humidity, but found the ant to be sensitive to desiccation at temperatures of 25°C and above.

In the United States they are found outside of building structures only in south Florida (below about latitude 29° 12’ N), with populations recorded in northern states only in glasshouses and other human structures (Thompson 1990; Deyrup et al. 2000).

The risk outdoors in New Zealand might usefully be assessed from the distribution of *T. melanocephalum* in Hawaii, where it is restricted to the dry lowlands (< 900 m) (Reimer 1994). This suggests that New Zealand is too cold. Ant species that occur in Hawaii’s colder mountainous areas (900–1800 m, Reimer 1994) include *Pheidole megacephala* (which has a very restricted northern distribution in New Zealand (Appendix 3)) and *Linepithema humile*. *Linepithema humile* also extends into the dry subalpine communities in Hawaii (1800–2700 m (Reimer 1994)), and its New Zealand distribution extends into the South Island (Appendix 3).

C1.3 BIOSECURE analysis

149 locality records were used for the assessment of *T. melanocephalum.* Africa was assumed to be the native range, and the data used in the climate analysis originated mostly from the introduced range (Fig. 4).

Data from native + introduced range suggests overlap with all of New Zealand for mean annual temperature (MAT) and mean minimum temperature of the coldest month (MINT) (Fig. 5, Table 9 & 10) due to several records from heated buildings in cold climates (yellow dots in Fig. 4, e.g., Canada (Francoeur 1977), northern USA (wwwnew55)). Average rainfall (PREC) may be limiting, but only in the highest rainfall areas (Fig. 5). There is generally low similarity for vapour pressure (VP) across New Zealand (Fig. 6a). Other climate parameters show little discrimination across New Zealand.

The native + introduced (non-urban) range shows no overlap of MAT and overlap of MINT only for the far North (Fig. 7). VP also shows a similar pattern to MINT with overlap between NZ and the international data only for northern areas (Fig. 6b). Rainfall is above the international range only in the wettest alpine areas (Fig. 7).

Climate summary

The general climate summary for the international range of *T. melanocephalum* indicates low similarity to New Zealand, particularly compared to *L. humile* (Fig. 8). Climate summary graphs are less useful than individual climate layers as contrasts in the risk between species and regions of New Zealand are less evident.

Climate match conclusions

Available data indicate that New Zealand is too cold for *T. melanocephalum* and this species is unlikely to establish outside of urban areas. There is a lack of sufficiently high temperatures over summer for foraging and colony development, and, over much of New Zealand, winter extremes are likely to be limiting. Mean annual temperatures recorded at the coldest sites where the ant is permanently established outside of urban areas are higher than recorded anywhere in New Zealand.

The species is capable of establishing in permanently heated buildings and therefore could establish anywhere in New Zealand if accidentally transported to suitable buildings.

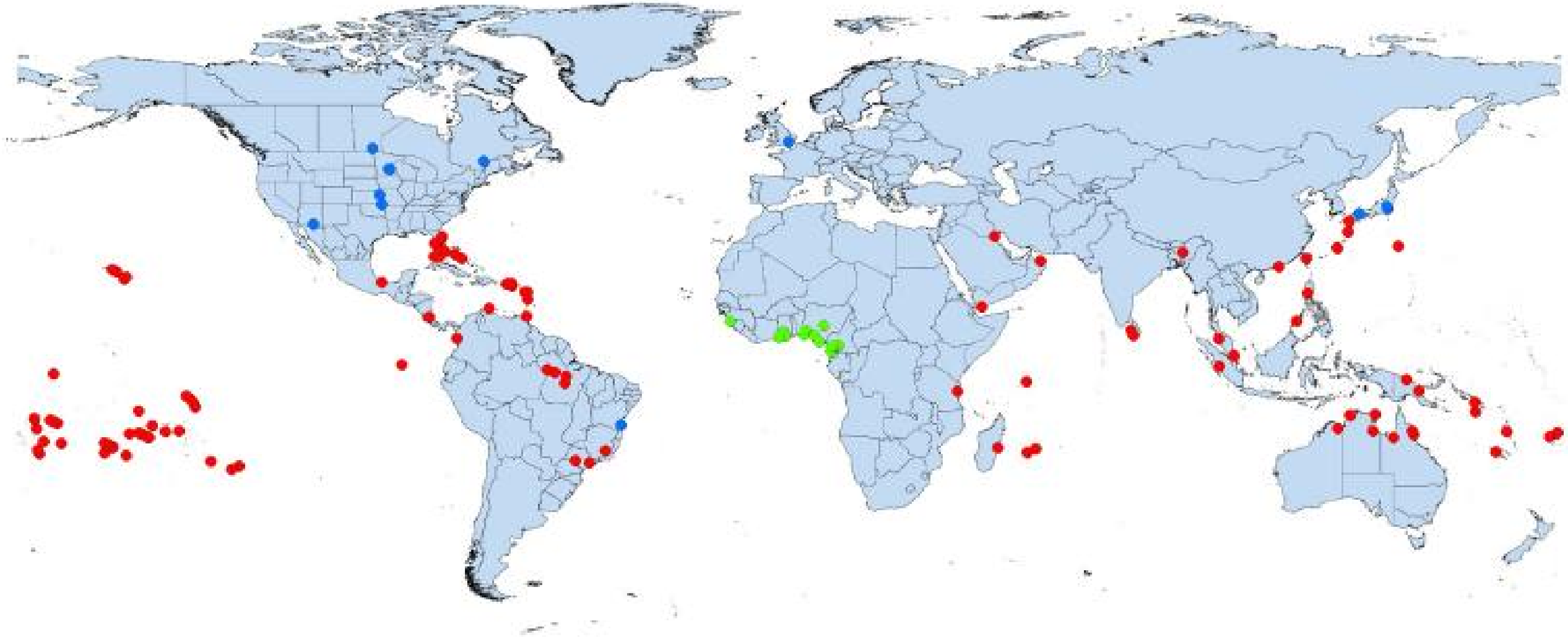

Fig. 4: *Distribution records used in BIOSECURE analysis of* T. melanocephalum. *These represent all records available at the time of analysis but are a subset of the distribution records presented in Fig. 2. Africa (green) is assumed to be the native range for analysis. Red dots represent the introduced range and blue dots those records that are from within heated buildings.*

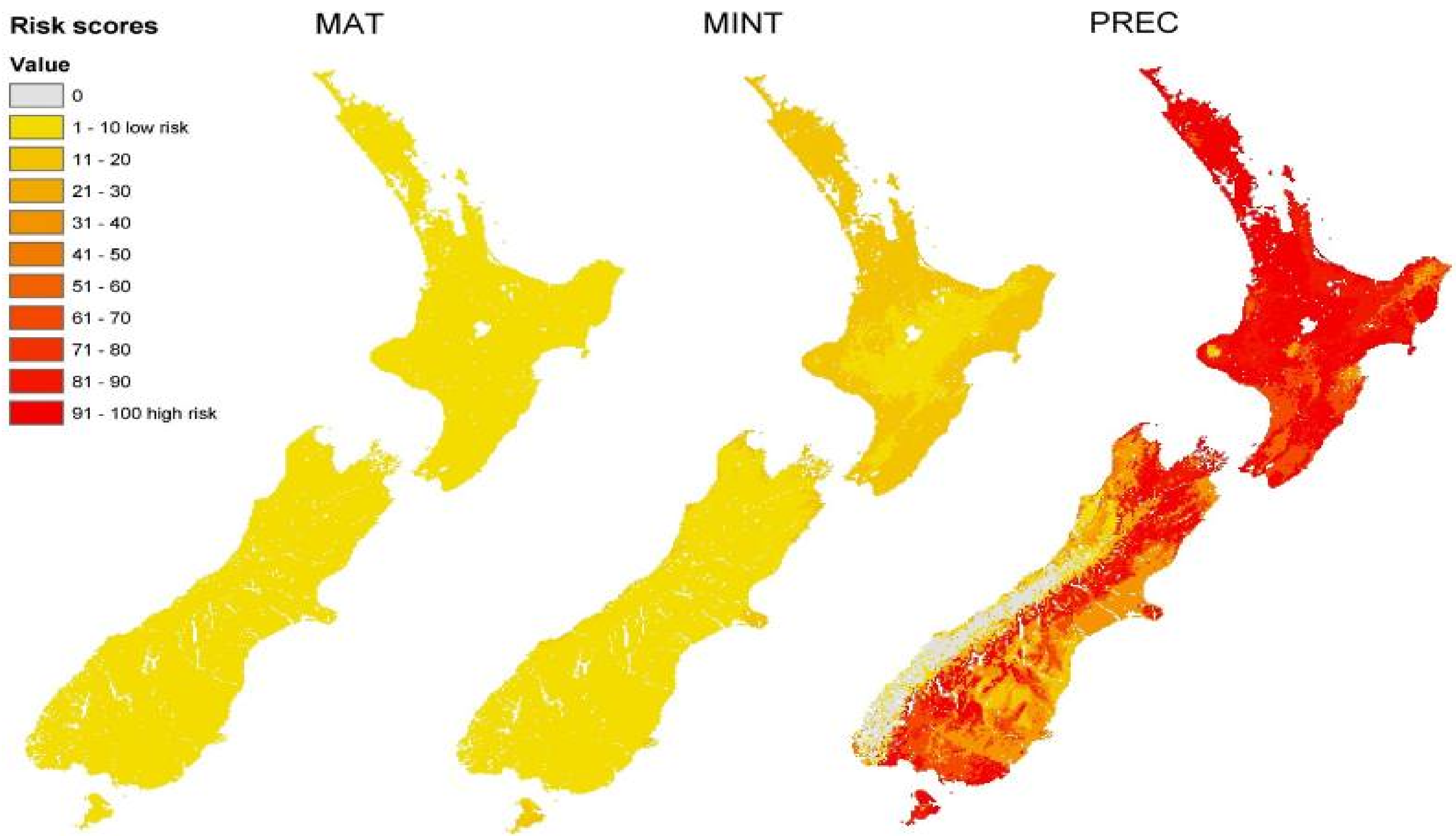

Fig. 5: *Similarity of native + introduced ranges of* T. melanocephalum *to New Zealand for MAT, MINT, and PREC.*

Table 9: Comparison of climate parameters for native and introduced range of *T. melanocephalum.*

Parameter	n	Mean	Minimum	Maximum
Mean Annual Temperature (°C)				
Native Range	17.0	25.3	22.9	26.6
Introduced Range	132.0	23.7	2.7	29.2
Introduced (non-urban) Range	117.0	25.0	18.9	29.2
Minimum Temperature (°C)				
Native Range	17.0	19.6	16.1	23.1
Introduced Range	132.0	16.1	-21.5	25.8
Introduced (non-urban) Range	117.0	18.4	4.7	25.8
Mean Annual Precipitation (mm)				
Native Range	17.0	2123.0	1066.0	3156.0
Introduced Range	132.0	1750.0	17.0	4780.0
Introduced (non-urban) Range	117.0	1822.0	17.0	4780.0
Mean Annual Solar Radiation				
Native Range	17.0	13.1	10.3	17.5
Introduced Range	132.0	15.6	10.1	22.4
Introduced (non-urban) Range	117.0	15.8	11.8	22.4
Vapour Pressure (millibars)				
Native Range	17.0	25.6	20.0	28.0
Introduced Range	132.0	23.0	7.0	31.0
Introduced (non-urban) Range	117.0	24.4	13.0	31.0
Seasonality of Temperature (°C)				
Native Range	17.0	11.6	2.7	19.4
Introduced Range	132.0	8.5	0.8	37.7
Introduced (non-urban) Range	117.0	6.8	0.8	23.8
Seasonality of Precipitation (mm)				
Native Range	17.0	335.5	204.0	854.0
Introduced Range	132.0	183.8	5.0	670.0
Introduced (non-urban) Range	117.0	193.5	5.0	670.0
Seasonality of Vapour Pressure (millibars)				
Native Range	17.0	6.2	2.0	16.0
Introduced Range	132.0	7.9	2.0	20.0
Introduced (non-urban) Range	117.0	7.2	2.0	19.0

Table 10: Range of climate parameters from New Zealand (N = 196 GRIDS at 0.5 degree resolution). Data exclude distant island groups (Chatham, Bounty, Antipodes, Campbell, Auckland, and Kermadec Islands). See Table A2.1 (Appendix 2) for details of climate parameters.

Parameter	Min	Max	Mean
MAT	-0.5	16.6	10.9
MINT	-8.3	7.8	3.0
PREC	356.0	5182.0	1765.0
MAS	11.2	14.3	13.0
VP	4.0	15.0	9.7
MATS	6.4	10.6	8.8
PRECS	23.0	175.0	60.5
VPS	4.0	8.0	5.9

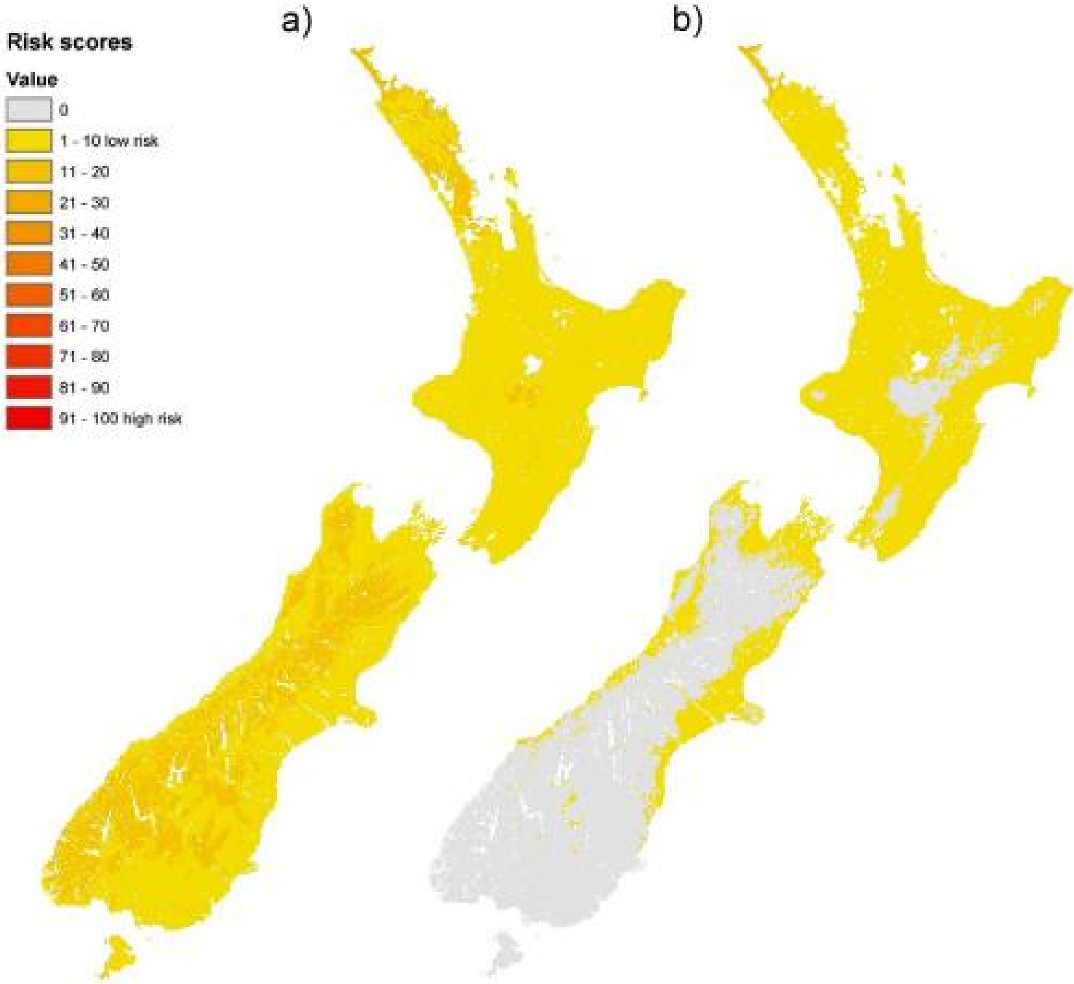

Fig. 6: *Similarity of a) native + introduced ranges and b) native + introduced non-urban ranges of* T. melanocephalum *to New Zealand for VP.*

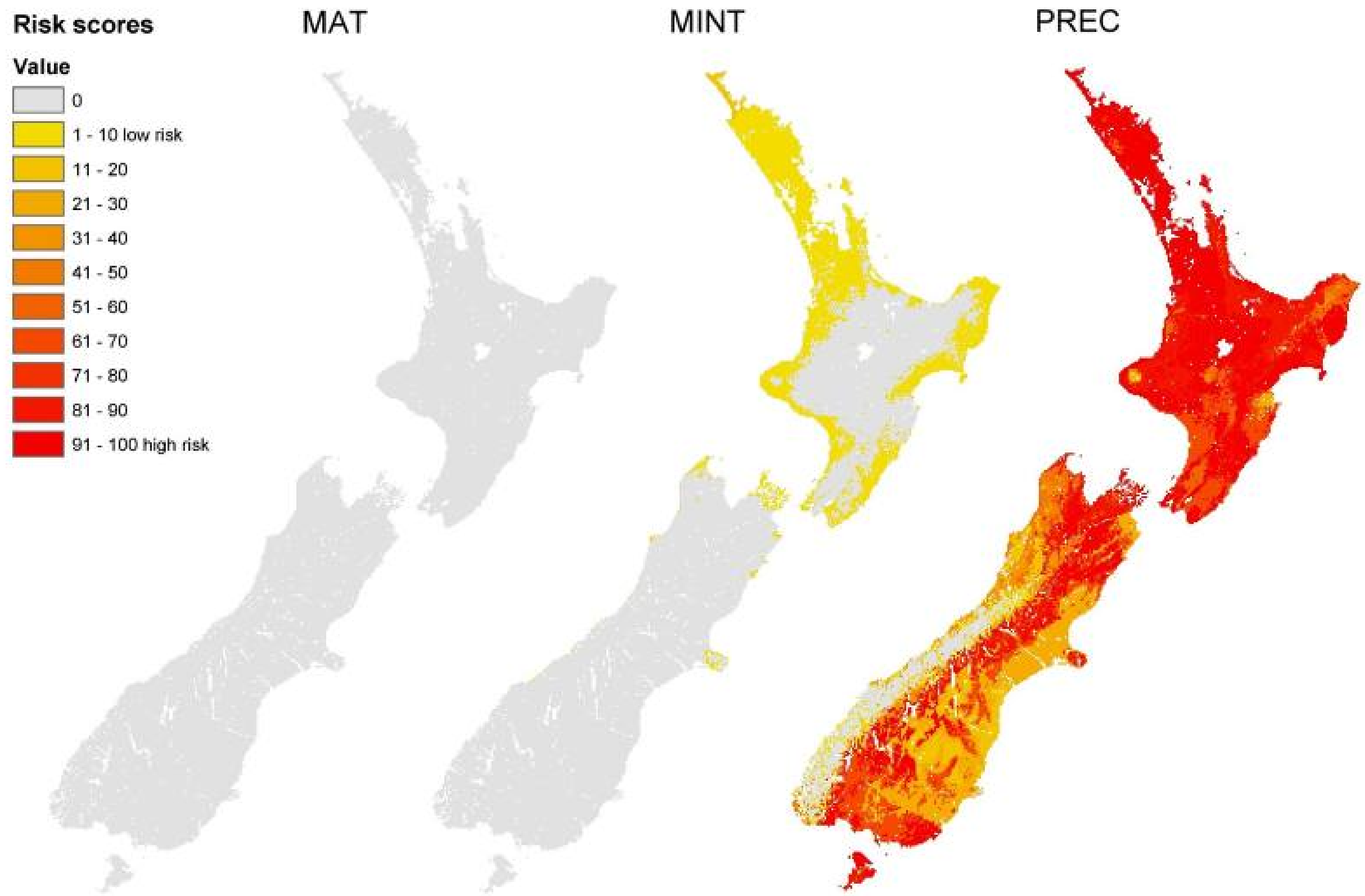

Fig. 7: Similarity of native + introduced non-urban ranges of T. melanocephalum *to New Zealand for MAT, MINT, and PREC.*

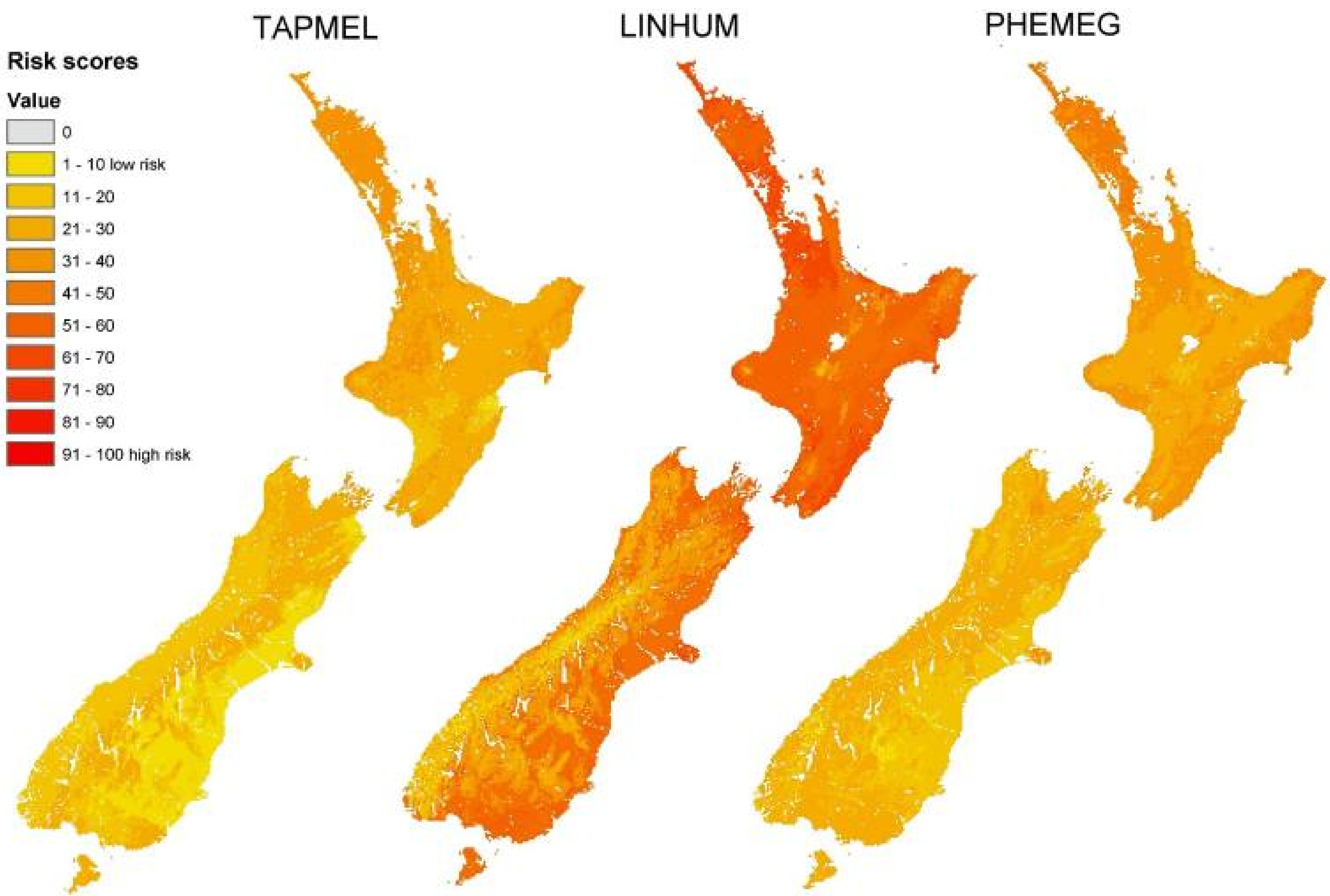

***Fig. 8:** Comparison of climate similarity of New Zealand and the international non-urban ranges of* T. melanocephalum, L. humile *and* Ph. megacephala *based on the mean of the similarity scores of five climate layers (MAT, MINT, PREC, VP, and PRECS). This presentation approximates that produced by the risk assessment tool Climex.*

C2. Potential to establish in protected environments

As described above, *T. melanocephalum* is very adaptable. It is closely associated with disturbed environments, and will readily establish in greenhouses, apartment buildings, hospitals and other urban buildings in temperate locations.

C3. Documented evidence of potential for adaptation of the pest

No information found.

C4. Reproductive strategy of the pest

Colonies of *T. melanocephalum* are polygyne, show a lack of intercolonial aggression, and frequently exchange workers between neighbouring colonies (Smith 1965; wwwnew45). Colonies are highly mobile and will relocate if disturbed (Passera 1994). Queens have a short life span (Harada 1990). Although it is not known if they have a nuptial flight (Passera 1994), it seems unlikely, and new colonies are formed by budding (Smith 1965).

C5. Number of individuals needed to found a population in a new location

Workers are probably sterile, like other tramp ants (Passera 1994). As queens have a very short lifespan of a few weeks (Harada 1990) and dispersal is reported to be by budding, a queen or queens in association with workers would probably be needed to successfully found a colony in a new location.

C6. Likely competition from existing species for ecological niche

Tapinoma melanocephalum appears to be frequently displaced or numerically dominated by a number of other species, but in many situations is able to survive and flourish where there is frequent disturbance and creation of new habitats. In "Biosphere 2", a highly artificial glass house community, *Paratrechina longicornis* dominated the enclosure and *T. melanocephalum* was only found on a single tree (Wetterer et al. 1999). Successful reduction of *Monomorium* spp. (*M. pharaonis, M. destructor,* and *M. floricola*) from buildings in Malaysia resulted in an increase in *T. melanocephalum* (and *P. longicornis*) activity, indicating that the *Monomorium* spp. were dominant (Lee 2002). Fowler et al. (1994) found *P. longicornis* and *T. melanocephalum* in 49 of 80 banana plantations surveyed in Sao Paulo, Brazil, but in no cases did they co-occur, and both were absent from tea and cocoa crops and native vegetation. In Bahia, Brazil, *Pheidole megacephala* was the only species that was truly dominant in houses and it was negatively associated with other common species including *T. melanocephalum, Solenopsis saevissima, P. longicornis,* and *Wasmannia auropunctata* (Delabie et al. 1995). In contrast, *T. melanocephalum* usually occurred with other ants. In southeastern Brazil, a native species *Crematogaster* c.f. *magnifica* Santschi was behaviorally dominant, but *T. melanocephalum* was the most frequent ant present in dwellings (Fowler & Bueno 1995). In Tokelau, *T. melanocephalum* was present in low numbers in forest dominated by *Anoplolepis gracilipes* (Lester & Tavite 2004).

It appears that this species is only likely to occur in New Zealand in buildings. There are currently one native (*Monomorium antipodum*) and two adventive species (*M. pharaonis and Technomyrmex albipes*) that nest within buildings. *Monomorium antipodum* has not been reported as abundant, but the other two species can be abundant in some buildings. The distribution of both is very patchy around New Zealand, and in urban areas where they have been for many years. *Technomyrmex albipes* has a wider distribution than *M. pharaonis*, with the later only been reported from large centrally heated commercial buildings (e.g., hospitals) rather than residential properties where *M. antipodum* and *T. albipes* also occur (R. Harris, pers. obs.). It is unclear if this patchiness reflects limited dispersal abilities or limited availability of suitable nesting sites. Both *M. pharaonis* and *T. albipes* may compete for nesting sites with *T. melanocephalum*. These three species have been reported within the same ant communities elsewhere (Lee 2002), but it is not clear if they coexist on the same trees or within the same buildings.

C7. Presence of natural enemies

No information was found on predators, parasites or parasitoids that attack *T. melanocephalum*. In Costa Rica, a salticid spider (*Continusa* sp.) that resembles the ant builds silken retreats at the periphery of nests, seems to emigrate with the host, and is probably a symbiont (Shepard & Gibson 1972). The spiders provide the ants with protection from predators and parasites, while the ant nest is used as a foundation for web construction.

C8. Cultural practices and control measures applied in New Zealand that may affect the ant's ability to establish

Practices at the point of incursion (e.g., seaports and airports) could affect the ability of *T. melanocephalum* to establish at those sites. Presently, there are no routine treatments of port areas that would decrease the chances of survival for *T. melanocephalum*, except for ongoing incursion responses. The most likely scenario for establishment of this species may be where a colony leaves its mode of transportation at the point of unloading rather than on the wharf. For air freight or personal effects it could be establishment within airport buildings, or the worst case scenario (in terms of preventing establishment), would be the initial incursion being in a residential home, which could easily go unnoticed.

Existing invasive ant surveillance in and around ports would only detect an incursion of *T. melanocephalum* if they were foraging outdoors (which may occur to some degree in summer) as no surveillance is currently conducted within buildings. Ant infestations within buildings are often treated by pest controllers, but are seldom sampled, e.g., there are relatively few specimens in New Zealand's entomological collections of *Monomorium pharaonis* and *Technomyrmex albipes* collected from within buildings, even though at least the latter species is widespread in urban areas of New Zealand. Addition of some ant surveillance within buildings at airport terminals (particularly Auckland) and major freight devanning sites is essential to increase chances of early detection of a *T. melanocephalum* incursion.

(D) LIKELIHOOD OF SPREAD AFTER ESTABLISHMENT

D1. Dispersal mechanisms

There are two methods of dispersal that, together will aid the spread of *T. melanocephalum* should it establish in New Zealand. Spread from an establised colony will occur by budding (Smith 1965; Bustos & Cherix 1998). Queens walk on foot accompanied by workers to a new nesting site. This method of dispersal will result in movement over relatively short distances and ensure that *T. melanocephalum* becomes dispersed throughout suitable habitat within large buildings that they infest (e.g., hospitals). However budding will also aid human-assisted dispersal over greater distances. In urban environments colonies can spread into, and be transported on, a huge variety of household goods, e.g., laptops (MAF interception), potted plants (wwwnew45), luggage (Appel et al. 2004), cut flowers (Appel et al. 2004), instrument case lining (Harada 1990), piles of clothing (Harada 1990), and probably a wide variety of other goods. The main requirement for successful transfer is that the goods end up in a suitably heated environment.

D2. Factors that facilitate dispersal

Disturbance: Budding will likely occur in the expansion phase of a colony when the nest population is expanding and nest sites become too small. Disturbance of colonies may also facilitate movement to a new location. This movement will likely occur across very limited distances, and may only occur within buildings.

Property movement: In Brazil, *T. melanocephalum* was found to be a rapid colonizer, being the only species found when houses were new (Delabie et al. 1995). It is possible the colonies were transported with building material or potted plants. Commerce has clearly assisted this ant to become widely dispersed globally and its habit of nesting in close association with urban environments promotes human-assisted dispersal. Movement of colonies that have formed in pot plants, containers, rubbish bins, boxes etc. will be of primary importance to the chances of *T. melanocephalum* becoming widespread in New Zealand. The cessation of movement of risk goods within an incursion zone would be critical to the successful eradication of this species.

D3. Potential rate of spread in its habitat range(s)

With a likely absence of winged dispersal, potential rates of spread in new habitats will be limited (provided human-assisted dispersal is eliminated). No information was found on dispersal rates of *T. melanocephalum*. However rates of spread via budding will likely be less than those of *Linepithema humile* given the limited availability of suitable habitat, smaller size of the ant, and its inability to achieve dominance over other ants it encounters. For *L. humile* expansion typically occurs over a relatively small scale (<150 m/year), with estimates ranging from near zero in areas of climatic extremes up to 800 m/yr in highly favourable habitat recently invaded (Holway 1998; Way et al. 1997; Suarez et al. 2001).

The rate of spread via human-assisted dispersal would be much greater, and much less predictable. Colonies would be spread between urban centres in New Zealand, but also moved over relatively short distances (e.g., between buildings within urban areas). For *L. humile* in New Zealand, the median human assisted dispersal distance was estimated between 10 and 72 km (Ward et al. 2005). There is no reason to expect human assisted dispersal distances to be different for *T. melanocephalum*, but the rate of successful establishment may be lower than for *L. humile* due the more specific requirement of suitably heated building in which to nest.

D4. Presence of natural enemies

Only other ant species are likely to limit the spread of this ant. Competition with dominant ant species present around the outside of buildings (e.g., *Linepithema humile* and *Doleromyrma darwiniana*) may limit the ability of *T. melanocephalum* to disperse between isolated buildings, if it does forage outside of buildings during summer. However, as foraging outdoors in Florida is restricted to southern areas (Deyrup et al. 2000), the ant appears unlikely to forage to any significant degree outdoors under New Zealand conditions.

(E) THE ENVIRONMENTAL, HUMAN HEALTH AND ECONOMIC CONSEQUENCES OF INTRODUCTION

E1. Direct effects

E1.1 Potential for predation on, or competition with New Zealand's indigenous fauna

All available evidence indicates *T. melanocephalum* will not establish outside of urban areas due to climate limitations. Urban areas, and specifically within buildings, have limited value in terms of native biodiversity, so there is unlikely to be any consequences of establishment of *T. melanocephalum* on New Zealand's indigenous fauna.

If climate predictions are wrong, and *T. melanocephalum* were to establish in warmer areas of New Zealand (in the far north of New Zealand and northern offshore island habitats), there is no evidence to suggest this species would be either highly populous or ecologically dominant to other fauna. It appears to be a highly opportunistic species whose success centres on its ability to live in highly disturbed environments and find food and nest sites rapidly before competing species colonise. Highly disturbed native habitats in New Zealand would include costal dunes, intertidal areas, geothermal areas, and possibly coastal scrub habitats. There could be some detrimental impacts on native fauna if the total ant biomass at a site increased as a result of establishment, but this is not considered likely given the limited climate suitability and general low abundance in most tropical communities where it has been studied (see section A7.1). If this ant did become abundant at a site, the invertebrate community would be most affected, due to increased competition for food and direct predation.

Disturbed native habitats are also those where *Linepithema humile* is most likely to establish outside of urban areas (Harris et al. 2002). Any impacts of *T. melanocephalum* establishment would probably be insignificant in comparison to those of *L. humile*. *Tapinoma melanocephalum* and *L. humile* may not coexist at a local scale, with *T. melanocephalum* being displaced.

Any natural dispersal into northern native habitats would take many years because of the dispersal mechanisms of this ant. Localities with low visitation rates, especially by boat or vehicle, may never have colonies transported into the area. Natural dispersal to such areas is unlikely due to the lack of suitable habitat between it and urban areas.

E1.2 Human health-related impacts

Populations of this ant in commercial premises (e.g., food outlets, hospital, retirement homes) would require treatment. Large populations can build up within buildings and some information suggests they can vector disease causing pathogens (Olaya & Chaco ́n 2001, cited in Ulloa-Chacon & Jaramillo 2003; Fowler et al. 1993) and cause skin irritation when people come into contact with foragers.

E1.3 Social impacts

Urban areas are likely to be invaded in New Zealand. Populations would likely be sufficiently abundant in large heated buildings (e.g., hospitals, office blocks, apartment buildings, factories) for pest control measures to be instigated. Foragers would feed on any food left out, and be a general nuisance and contaminant through foraging and nesting in a wide variety of locations.

It is uncertain if this ant will become sufficiently abundant to be considered a pest in residential properties (other than apartment buildings) due to the lack of constant heating throughout winter. They are unlikely to be a nuisance outdoors in urban areas.

E1.4 Agricultural/horticultural losses

No reference was found to any direct agricultural/horticultural losses caused by *T. melanocephalum*. Foragers will tend honeydew-producing insects (Smith 1936, cited in Fowler et al. 1990; Smith 1965; Fowler et al. 1990; Appel et al. 2004) and potentially could be considered a pest within glasshouse environments if honeydew-producing insects were to increase in abundance. There is also a high probability of contamination of produce and cut flowers produced in glass houses (one of the most common border interception associations in New Zealand and Australia are with cut flowers, particularly Orchids). However this would be countered to some degree by beneficial effects through predation of pests (Pimental 1955, cited in Smith 1965; Gomez-Nunez 1971; Chelliah & Srinivasan 1986; Osborne et al. 1995). Establishment in commercial premises such as horticultural processing plants could result in product contamination.

Establishment in facilities with captive invertebrates (e.g., research laboratories, quarantine facilities) could have detrimental implications resulting from predation as has been reported overseas (Nickerson & Bloomcamp 1988, cited in Osborne et al. 1995).

E1.5 Effect(s) on existing production practices

Implementation of ant control would be necessary should *T. melanocephalum* become established in commercial buildings where *Technomyrmex albipes* or *M. pharaonis* are not already a pest. In glasshouses producing produce for export, treatment would be necessary to stop contamination if there is not already some form of pre-export insect treatment.

E1.6 Control measures

(This section makes extensive use of the review of baiting by Stanley (2004))

There are no documented reports of eradication of populations of this species (Stanley 2004). Most of the research has been on management of infestations within urban areas where *T. melanocephalum* is one of a suite of ants that are pests. Foragers will take baits but it can be difficult achieving effective control (Lee 2002).

Bait matrix (attractant + carrier): Field trials in Malaysia using baits found *T. melanocephalum* was attracted to both peanut butter and honey (Lee 2002). Lee and Kooi (2004) recommend using sugar-based attractants in liquid or gel baits to target *T. melanocephalum*, although protein and oil-based foods may also be attractive. Lee (2002) reported limited success using paste and granular bait formulations to control *T. melanocephalum* and Hedges (1996) also reports difficulties trying to control this species with toxic baits.

Toxicants and commercial baits: Boric acid (1%) in sucrose water is effective at eliminating *T. melanocephalum* laboratory colonies within 8–12 weeks (Klotz & Williams 1996; Klotz et al. 1996). In the same laboratory trial, Maxforce® (hydramethylnon in silkworm pupae protein matrix) had little or no effect on workers or colonies because very little was consumed (Klotz et al. 1996). In laboratory trials using hydramethylnon at higher concentrations (Siege®: 2% hydramethylnon) or Dimlin® (diflubenzuron) in sucrose liquid baits, only limited control of *T. melanocephalum* colonies was achieved after 9 weeks (Ulloa-Chacon & Jaramillo 2003). In contrast, fipronil (0.05%) in sucrose liquid baits killed all laboratory colonies within a week (Ulloa-Chacon & Jaramillo 2003).

Sucrose water exploits the natural feeding habits of honeydew-collecting ants and also provides moisture (Klotz et al. 1996). There is also the possibility that water regulation is disrupted when using boric acid, causing ants to ingest more of the bait to counteract dehydration (Klotz et al. 1996). However, liquid baits are not suitable for broadcast baiting, and must be available continuously, making control very labour-intensive (Klotz et al. 1998). Non-target issues are also greater when using sweet baits, but this is less of an issue within buildings. Fipronil in sugar syrup baits (sweet, liquid baits) could be used to control a limited *T. melanocephalum* incursion in New Zealand. Xstinguish™ is a possible candidate for the control of *T. melanocephalum*, but its attractiveness and efficacy against *T. melanocephalum* has not been investigated and needs to be compared compared to fipronil (0.05%) in sugar syrup and boron-based liquid baits (<1% in sugar syrup).

E2. Indirect effects

E2.1 Effects on domestic and export markets

No effects on domestic or export markets have been recorded. However, if *T. melanocephalum* was to become established in New Zealand and transported to another country where it was absent, it could affect import health standards applied to New Zealand exports. However, with the very wide distribution of this ant many cities with international ports, particular those in tropical and subtropical zones, are likely to already have this ant.

E2.2 Environmental and other undesired effects of control measures

There have been no documented cases of adverse non-target effects arising directly from the use of toxic baits for control of *T. melanocephalum.* However, bait will be toxic to other inverts that consume it, and care would need to be taken to ensure commercial products were not contaminated with insecticide. The toxicant fipronil, widely used in ant control programs, is currently under review in Australia due to reports of negative effects to non-target species and human health (APVMA 2003).

There is no documented evidence of resistance of any ant to pesticides.

(F) LIKELIHOOD AND CONSEQUENCES ANALYSIS

F1. Estimate of the likelihood

F1.1 Entry

Tapinoma melanocephalum currently has a *high* risk of entry.

This assessment is based on:

- *T. melanocephalum* having been intercepted frequently at the New Zealand border (51 times between 1997 and end 2002, and a further 36 interceptions between start of 2003 and March 2004 during a period of full reporting of interceptions).
- interception records indicating ability to stowaway on a wide variety of commodities.
- dispersal being primarily by budding, colonies being polygyne and polydomous, and mobile. It also nests inside buildings and other man-made objects. These characteristics promote the chances of workers and queens being transported.
- *T. melanocephalum* being widespread in the Pacific – a high risk pathway for ants entering New Zealand.

Data deficiencies

- not all ants intercepted at the New Zealand border are reported and it is likely that they underestimate entry of this species (as evident by the increase in interception reports during the recent period of full reporting). It is also not always clear in interception data if castes other than workers were intercepted.

F1.2 Establishment

Tapinoma melanocephalum currently has a *medium* risk of establishment.

This assessment is based on:

- available climate information suggesting this tropical species is highly unlikely to establish outdoors in New Zealand.
- it being able to establish in temperate regions in close association with heated buildings which are in close proximity to ports of entry and transitional facilities.
- interceptions are mostly of workers, with only one queen and one nest being intercepted. Also a nest, of unknown origin, was found on a Ports of Auckland wharf in summer 2002-2003. A queen accompanied by workers being required for successful establishment.
- it is unlikely to encounter natural enemies, but there would be competition from other adventive ants that occur within buildings.
- there being numerous pathways from our Pacific neighbours for budded colonies to arrive in New Zealand.

Surveillance targeting other invasive ants (particularly *S. invicta*) may not detect this species as it will likely nest indoors.

Data deficiencies

- there is no experimental data on developmental rates or foraging activity in relation to temperature. The climate assessment is based on consideration of climate estimates from known sites of establishment of *T. melanocephalum*, and its distribution outdoors in mainland US, Hawaii, and Australia.

- there are no established protocols for successful eradication of a large incursion of this species.

F1.3 Spread

Tapinoma melanocephalum has a *medium* risk of spread from a site of establishment.

This assessment is based on:

- areas of New Zealand considered climatically suitable to spread into being available, although limited to heated buildings in urban areas.
- suitably heated buildings for establishment being patchily distributed restricting dispersal by natural means. Human-assisted dispersal of propagules between suitably heated buildings and glasshouses would likely be the main mode of dispersal.
- colony development being relatively slow. It is likely sub-optimal temperatures will restrict foraging outdoors and the rate of colony development. This will extend the period from colony founding to the production of reproductives and colonies of sufficient size to undergo budding.
- treatment of infestation in buildings will restrict rate of spread.

Data deficiencies

- the types of buildings that would be sufficiently warm for this ant to establish in are unknown.
- there is a lack of experimental data on the colony status (size and abiotic cues) that promotes budding in polygyne species.
- it is unknown whether this ant has persisted and how widespread it has become in the many temperate locations from which it has been reported.

F1.4. Consequences

The consequences of the presence of *T. melanocephalum* in New Zealand are considered *low*.

This assessment is based on:

- there being few medical consequences of establishment as the ant does not sting or spray formic acid, but has been recorded to cause mild skin irritation.
- the ant likely being a nuisance pest indoors. It can be an occasional pest in commercial premises and kitchens through product contamination, and spread disease in hospitals. Pest control would likely be initiated anywhere this ant was abundant.
- it occurring in similar situations to *M. pharaonis*, which is reported occasionally in New Zealand in hospitals and commercial buildings.
- it being considered extremely unlikely there will be any environmental consequences, even if the ant did establish in native habitats. In optimal climates this species is not ecologically dominant, foraging in low numbers and often being displaced by other ant species.

Data deficiencies

- although predicted that pest control would be initiated anywhere this ant was abundant, it is unknown what conditions in urban areas would promote the ant attaining high population densities. It is thought this may more likely occur in large centrally heated buildings, like hospitals, than in domestic dwellings.
- *T. melanocephalum* is similar in biology to *M. pharaonis*. Although established in New Zealand, *M. pharaonis* is seldom reported and it is unclear how widespread and how often management of this species is undertaken.

F2. Summary table

Ant species: *Tapinoma melanocephalum*

Category			Overall risk
Likelihood of entry	High	Widespread. Relatively frequently intercepted.	Medium
Likelihood of establishment	Medium	Unlikely outside of heating buildings, reducing probability of propogules getting to suitable locations.	
Likelihood of spread	Medium	Human-mediated spread, but only between suitably heated buildings.	
Consequence	Low	Very localised impacts. Some product and food contamination. Disease spreading potential. Can cause skin irritation.	

A detailed assessment of the Kermadec Islands is beyond the scope of this assessment.

(G) References

(NB: a copy of all web page references is held by Landcare Research (M. Stanley) should links change)

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(I) Acknowledgements

Thanks to Anne Sutherland for assistance with GIS maps, Jo Rees for help obtaining references, Jo Berry for compiling the taxonomic section, Phil Lester, Anne Austin and Phil Cowan for reviewing text, and Kerry Barton for assistance with formatting.

(J) Appendices

Appendix 1: Freight summary

Table a. Summary of sea freight coming to New Zealand from localities within 100 km of known sites with *T. melanocephalum.* Values represent the total freight (tonnes) during 2001, 2002 and 2003. Total freight is broken into different commodity types (source: Statistics New Zealand). NB: New Zealand received some freight from all locations listed, but if total freight is below 500 kg it is listed as 0 tonnes. Details of freight types that comprise each category are given (c) as are the categories (HS2 Chapters) used to classify incoming freight in the Statistics New Zealand database (d).

Country	Port or export	Total freight	Appliances	Fibres	Bulk	Foodstuffs	Furniture	Furs	Glass	Metals	Produce	Wood	Other
American Samoa	Pago Pago	18772	929	3	21	5	0	0	0	17796	0	0	17
Australia	Cairns, QL	117546	0	0	0	68684	0	0	0	0	0	0	48862
Australia	Darwin, NT	1035	134	9	463	142	3	0	1	109	0	16	158
Bahrain	Bahrain	4688	0	1	0	0	0	0	0	4672	0	0	15
Brazil	Blumenau, SC	17	0	0	0	0	0	0	0	0	0	0	17
Brazil	Campinas, SP	20	3	0	0	17	0	0	0	0	0	0	0
Brazil	Itajai, SC	380	45	7	1	259	19	0	0	39	0	9	0
Brazil	Santarem, PA	57	1	0	0	31	0	0	0	0	0	26	0
Brazil	Sao Francisco do Sul, SC	6817	3111	299	0	437	72	0	2320	72	0	423	84
Brazil	Viracopos Apt/Sao Paulo, SP	16	0	0	0	0	0	0	0	0	0	0	16
Brunei Darussalam	Muara	21	21	0	0	0	0	0	0	0	0	0	0
Cameroon	Douala	273	0	0	0	0	0	0	0	0	0	273	0
Canada	Quebec Apt, QC	56	4	0	0	0	9	0	13	30	0	0	0
Canada	Quebec, QC	198	40	5	63	6	0	0	0	68	0	13	2
Canada	Winnipeg Apt, MB	678	18	0	0	325	330	0	0	5	0	0	0
Canada	Winnipeg, MB	725	41	0	0	283	375	0	0	12	0	0	14
China	Chiwan	2957	202	65	1851	188	155	5	31	281	71	40	68
China	Fuzhou	171456	742	142	164055	96	906	18	2533	547	5	174	2238
China	Haikou	15418	6	70	15000	105	41	7	0	42	0	136	11
China	Huangpu	38933	2482	1098	15217	4050	2892	146	4452	3498	201	1850	3047
China	Shekou	2012	87	30	106	170	149	5	889	314	35	104	124
China	Shenzhen	3347	288	53	105	106	392	51	1913	254	0	55	130
China	Yantian	13267	3561	167	95	103	3887	183	1961	1922	6	321	1062
China (Hong Kong)	Hong Kong SAR	455059	64385	33371	154811	27265	32065	5596	27075	60995	3831	9946	35718
China (Hong Kong)	Kowloon	188	10	20	0	0	42	30	1	36	0	37	14
China (Macau)	Macau	26	6	12	0	0	0	1	0	1	0	1	4
Christmas Island	Christmas Island	31500	0	0	31500	0	0	0	0	0	0	0	0
Cook Islands	Aitutaki	93	67	0	0	0	0	0	0	2	22	0	1

Country	Port or export	Total freight	Appliances	Fibres	Bulk	Foodstuffs	Furniture	Furs	Glass	Metals	Produce	Wood	Other
Cook Islands	Rarotonga	927	127	0	0	404	9	0	109	147	9	13	109
Costa Rica	Puerto Limon	292	0	0	0	254	0	0	0	5	33	0	0
Costa Rica	San Jose	120	0	0	0	52	0	0	0	0	69	0	0
Dominica	Portsmouth	976	913	0	0	25	4	0	0	31	0	1	0
Dominican Republic	Santo Domingo	74	0	0	0	0	0	0	22	52	0	0	0
Federated States of Micronesia	Yap	7	0	0	0	7	0	0	0	0	0	0	0
Fiji	Lautoka	13455	574	219	0	7892	160	4	1	817	1570	1296	921
Fiji	Nadi	839	4	2	0	16	0	0	0	14	774	0	28
Fiji	Savusavu	66	1	0	0	0	0	0	0	0	0	65	0
Fiji	Suva	40544	940	464	83	8512	290	3	82	2211	18069	9328	562
Finland	Oulu (Uleaborg)	3125	0	0	0	0	0	0	0	3125	0	0	0
French Polynesia	Papeete	5364	321	1	6	4530	9	0	0	463	11	1	21
Guam	Guam	50	2	48	0	0	0	0	0	0	0	0	0
Guyana	Georgetown	2598	0	0	21	0	0	0	0	2004	0	573	0
India	Bangalore	1599	7	16	104	802	38	0	256	181	58	62	75
India	Bombay (Mumbai)	31975	890	3753	6603	5258	744	191	4196	5475	1469	401	2994
India	Calcutta	13477	28	2441	423	118	2	75	522	9724	35	1	107
India	Haldia	4588	67	117	843	0	0	0	47	3497	0	2	13
Indonesia	Ambon, Molucas	12412	0	0	12412	0	0	0	0	0	0	0	0
Indonesia	Jakarta, Java	627407	7678	6649	482350	25252	2467	74	21925	45631	26	28056	7300
Indonesia	Padang (Teluk Bajur), Sumatra	7689	0	9	0	6224	0	0	0	40	0	1416	0
Indonesia	Surabaya-Tanjung Perak, Java	169249	265	996	26512	4472	4842	35	13355	20824	31	94828	3089
Jamaica	Kingston	2084	0	6	0	2016	0	0	0	0	23	38	0
Japan	Akitsu, Hiroshima	33	30	0	0	0	0	0	0	0	0	0	3
Japan	Chiba, Chiba	30452	1882	0	28570	0	0	0	0	0	0	0	0
Japan	Fukuoka, Fukuoka	524	516	0	0	4	0	0	1	2	1	0	0
Japan	Funabashi, Chiba	65477	65466	0	0	0	1	0	1	9	0	0	0
Japan	Hakata, Fukuoka	16258	8240	9	38	32	0	0	0	7913	21	1	5
Japan	Haneda Apt/Tokyo	44	17	0	0	19	0	0	0	8	0	0	0
Japan	Hiroshima, Hiroshima	25777	25604	3	19	4	0	0	27	85	0	26	10
Japan	Ikejima, Nagasaki	32	17	0	0	0	0	0	0	0	0	15	0
Japan	Itozaki, Hiroshima	51	51	0	0	0	0	0	0	0	0	0	0
Japan	Iwakuni, Yamaguchi	13	13	0	0	0	0	0	0	0	0	0	0
Japan	Iyomishima, Ehime	40	40	0	0	0	0	0	0	1	0	0	0
Japan	Kikuma, Ehime	2783	2782	0	0	0	0	0	0	0	0	0	0
Japan	Kimitsu, Chiba	6210	6053	6	0	0	0	0	1	42	0	106	2
Japan	Kumamoto, Kumamoto	35	35	0	0	0	0	0	0	0	0	0	0
Japan	Kure, Hiroshima	239	223	0	1	0	0	0	0	12	0	0	3
Japan	Kurushima, Ehime	33	31	1	0	0	0	0	0	0	0	0	0
Japan	Marugame, Kagawa	82	82	0	0	0	0	0	0	0	0	0	0
Japan	Miike, Fukuoka	71	44	0	0	0	0	0	0	26	0	0	0
Japan	Mizushima, Okayama	7118	7118	0	0	0	0	0	0	0	0	0	0
Japan	Nagasaki, Nagasaki	1147	1142	4	0	0	0	0	0	0	0	0	1
Japan	Naha, Okinawa	53	44	1	0	0	0	0	0	8	0	0	0

Country	Port or export	Total freight	Appliances	Fibres	Bulk	Foodstuffs	Furniture	Furs	Glass	Metals	Produce	Wood	Other
Japan	Narita Apt/Tokyo	27	18	0	0	0	0	0	0	2	0	0	8
Japan	Niihama, Ehime	6032	0	0	6032	0	0	0	0	0	0	0	0
Japan	Okinawa, Okinawa	31	26	0	0	0	0	0	0	5	0	0	0
Japan	Setoda, Hiroshima	3	3	0	0	0	0	0	0	0	0	0	0
Japan	Sodegaura, Chiba	35	1	0	0	0	0	0	0	0	0	34	0
Japan	Tokyo, Tokyo	106422	21527	233	46367	3553	373	3	394	29479	71	1513	2909
Japan	Yatsushiro, Kumamoto	8	6	0	0	0	0	0	0	2	0	0	0
Japan	Yokohama, Kanagawa	410100	256656	358	7301	9200	196	5	762	100878	173	18235	16335
Japan	Yokoshima, Hiroshima	71	69	0	0	0	0	0	2	0	0	0	0
Kuwait	Kuwait	457054	0	0	456458	20	0	0	0	574	0	0	2
Kuwait	Shuwaikh	62769	0	0	59933	20	0	0	0	2816	0	0	0
Malaysia	Bagan Luar (Butterworth)	299	0	0	0	279	0	0	0	0	0	0	20
Malaysia	Kota Kinabalu, Sabah	31106	9	0	0	30674	42	0	0	28	0	353	0
Malaysia	Kuala Lumpur	23218	1102	569	772	664	9374	2	3245	5404	8	1411	669
Malaysia	Pasir Gudang, Johor	120238	2267	180	177	92311	3555	5	10597	7282	5	2952	908
Malaysia	Penang (Georgetown)	30233	1752	748	258	7349	2379	1	623	10781	3	4846	1493
Malaysia	Port Kelang (Port Swettenham)	310463	13748	2833	114442	64152	15717	110	14352	57884	661	13392	13173
Malaysia	Prai	15	0	0	0	0	0	0	0	2	0	13	0
Malaysia	Sipitang, Sabah	7	0	7	0	0	0	0	0	0	0	0	0
Malaysia	Tanjong Pelepas	270508	16335	5042	105266	26303	5137	420	37261	38394	3643	24398	8308
Mauritius	Port Louis	1257	67	12	0	788	7	0	0	361	0	2	19
Nigeria	Apapa	20	0	0	0	0	0	0	0	0	0	20	0
Nigeria	Lagos	23	0	0	0	0	0	0	0	0	23	0	0
Niue	Niue Island	606	9	0	0	42	5	0	0	5	544	0	0
Oman	Min-al-Fahal	862459	0	0	862459	0	0	0	0	0	0	0	0
Oman	Muscat	351	2	0	0	312	0	0	0	38	0	0	0
Oman	Port Qaboos	180	0	0	0	174	0	0	0	6	0	0	0
Panama	Balboa	167	4	3	0	19	0	0	0	45	45	8	42
Panama	Colon	544	37	0	0	0	0	0	0	12	494	0	0
Panama	Cristobal	162	117	0	0	0	0	0	0	22	23	0	1
Panama	Panama City	147	8	9	0	93	0	19	0	6	0	2	9
Papua New Guinea	Kimbe	7382	0	0	0	6897	0	0	0	0	0	485	0
Papua New Guinea	Lae	6421	233	0	122	2587	31	0	1	402	0	2990	55
Papua New Guinea	Port Moresby	7025	248	0	10	1208	1	0	0	79	0	5467	11
Philippines	Batangas, Luzon	521	0	0	0	151	0	0	0	0	370	0	0
Philippines	Manila	25224	924	1401	719	9993	666	37	295	6839	2947	451	951
Puerto Rico	Ponce	703	0	0	0	699	0	0	0	0	0	0	5
Puerto Rico	San Juan	167	0	0	0	159	0	0	0	0	0	0	8
Reunion	St Denis de La Reunion	90	37	0	0	21	0	0	0	32	0	0	0
Russia	Moskva (Moscow)	50	0	11	0	0	0	0	0	39	0	0	0
Samoa	Apia	6594	411	14	1	3275	1	0	0	666	2166	38	23
Saudi Arabia	Damman	45126	102	1063	28140	82	0	0	20	15628	17	0	74
Saudi Arabia	Dhahran	26483	0	0	26419	0	0	0	0	64	0	0	0
Saudi Arabia	Ras Tanura	539060	0	0	539060	0	0	0	0	0	0	0	0

Country	Port or export	Total freight	Appliances	Fibres	Bulk	Foodstuffs	Furniture	Furs	Glass	Metals	Produce	Wood	Other
Singapore	Jurong	46	44	0	0	0	1	0	0	1	0	0	0
Singapore	Singapore	1204093	60294	16705	641019	76567	9858	583	47443	257168	7200	44352	42903
Singapore	Singapore Container Terminal	95555	8284	4242	10745	11364	1671	70	7422	37763	1991	6455	5547
Solomon Islands	Honiara, Guadalcanal Island	3205	83	1	63	471	0	0	0	0	312	2225	49
Spain	Barcelona	40661	5373	800	3659	6490	599	9	10320	6644	484	1417	4867
Sri Lanka	Colombo	11891	38	1241	218	5417	18	0	1266	2149	717	479	348
Switzerland	Zurich	409	220	12	3	0	4	0	10	127	0	1	33
Taiwan	Taichung	34258	1360	155	1109	972	1483	6	1089	27198	9	69	806
Tanzania	Dar es Salaam	4	0	0	0	2	0	0	0	0	0	2	1
Tonga	Neiafu	0	0	0	0	0	0	0	0	0	0	0	0
Tonga	Tongatapu-Nuku'alofa	5782	558	0	12	174	13	0	3	516	4335	159	12
Tonga	Vava'u	369	18	0	0	5	0	0	0	11	333	1	1
Trinidad and Tobago	Port of Spain	71	23	0	40	8	0	0	0	0	0	0	0
UK	London	6203	799	275	348	329	80	100	479	1676	0	193	1924
UK	London-Heathrow Apt	769	130	10	164	197	8	0	19	57	0	25	158
UK	Newhaven	1	1	0	0	0	0	0	0	0	0	0	0
UK	Sheerness	524	288	0	0	0	0	0	0	193	0	43	1
UK	Shoreham	1	1	0	0	0	0	0	0	0	0	0	0
UK	Tilbury	94434	13019	2031	2016	28947	710	22	3341	28214	17	2796	13322
USA	Brunswick, GA	37	37	0	0	0	0	0	0	0	0	0	0
USA	Buffalo, NY	0	0	0	0	0	0	0	0	0	0	0	0
USA	Fort Lauderdale, FL	43	28	0	0	15	0	0	0	0	0	0	0
USA	Freeport, TX	3517	0	0	0	0	0	0	0	3517	0	0	0
USA	Galveston, TX	15	15	0	0	0	0	0	0	0	0	0	0
USA	Honolulu, HI	335	43	3	0	16	19	0	0	219	0	0	35
USA	Houston, TX	152881	3481	83	11146	1526	166	257	1722	123544	92	4376	6486
USA	Jacksonville, FL	41	3	0	3	0	0	0	0	3	0	10	23
USA	Miami, FL	596	197	13	1	4	24	0	6	109	10	23	209
USA	Minneapolis/St Paul Apt, MN	68	7	1	0	0	1	0	11	15	0	0	33
USA	New Orleans Intl Apt, LA	456	1	0	0	26	0	0	0	301	0	120	7
USA	New Orleans, LA	68718	185	6	38821	28801	1	0	94	661	0	72	77
USA	Norfolk, VA	96532	2186	473	69480	11647	62	1	1622	2812	3830	1908	2512
USA	Norfolk-Newport News, VA	2806	152	10	92	559	6	0	508	362	0	988	128
USA	Orlando, FL	80	4	0	9	0	2	0	0	29	0	0	36
USA	Pearl Harbour, HI	2	2	0	0	0	0	0	0	0	0	0	0
USA	Port Everglades, FL	2	2	0	0	0	0	0	0	0	0	0	0
USA	St Petersburg, FL	51	0	0	0	0	0	0	0	51	0	0	0
USA	Tampa, FL	272758	23	0	272714	0	0	0	0	20	0	0	1
USA	Texas City, TX	2134	9	0	1	0	13	0	0	2098	0	0	13
Wallis & Futuna Islands	Futuna Island	19	12	0	0	5	0	0	0	0	1	0	0

Table b. Summary of air freight coming to New Zealand from localities within 100 km of known sites with *T. melanocephalum*. Values represent the total freight (tonnes) during 2001, 2002 and 2003. Total freight is broken into different commodity types (source: Statistics New Zealand). NB: New Zealand received some freight from all locations listed, but if total freight is below 500 kg it is listed as 0 tonnes. Details of freight types that comprise each category are given (c) as are the categories (HS2 Chapters) used to classify incoming freight in the Statistics New Zealand database (d).

Country	Port of export	Total freight	Appliances	Produce	Pharmaceuticals	Metals	Glass	Furniture	Fur	Footwear	Foodstuffs	Fibres	Other
American Samoa	Pago Pago	2	1	0	0	0	0	0	0	0	0	0	0
Antigua and Barbuda	Antigua	0	0	0	0	0	0	0	0	0	0	0	0
Australia	Cairns, QL	77	5	2	0	1	0	1	0	0	63	0	4
Australia	Cooktown, QL	0	0	0	0	0	0	0	0	0	0	0	0
Australia	Darwin, NT	5	4	0	0	0	0	0	0	0	0	0	1
Bahrain	Bahrain	8	0	0	0	7	0	0	0	0	0	0	0
Belize	Belize City	0	0	0	0	0	0	0	0	0	0	0	0
Brazil	Belo Horizonte	1	0	0	0	0	0	0	0	0	0	0	0
Brazil	Blumenau, SC	0	0	0	0	0	0	0	0	0	0	0	0
Brazil	Campinas, SP	8	0	0	0	0	0	0	0	5	0	3	0
Brazil	Guarulhos Apt/Sao Paolo, SP	20	7	0	0	0	0	0	0	1	4	2	6
Brazil	Santos, SP	2	0	0	0	0	0	0	0	2	0	0	0
Brazil	Viracopos Apt/Sao Paulo, SP	29	3	0	0	7	1	0	0	3	0	13	1
Canada	Quebec Apt, QC	1	0	0	0	0	0	0	0	0	0	0	0
Canada	Quebec, QC	4	3	0	0	0	0	0	0	0	1	0	0
Canada	Winnipeg Apt, MB	3	1	0	1	0	0	0	0	0	0	0	1
Canada	Winnipeg, MB	1	0	0	0	0	0	0	0	0	0	0	1
China	Fuzhou	15	3	0	0	3	1	0	1	1	1	4	2
China	Haikou	2	1	0	0	0	0	0	1	0	0	0	0
China	Huangpu	1	0	0	0	0	0	0	0	0	0	0	1
China	Shekou	1	0	0	0	0	0	0	0	0	0	0	0
China	Shenzhen	8	2	0	0	1	0	1	0	0	0	2	2
China	Yantian	0	0	0	0	0	0	0	0	0	0	0	0
China (Hong Kong)	Hong Kong SAR	7514	2458	2	53	615	51	434	203	237	87	2301	1073
China (Hong Kong)	Kowloon	2	1	0	0	0	0	0	0	0	0	1	0
China (Macau)	Macau	6	2	0	0	4	0	0	0	0	0	0	0
Colombia	Medellin	1	0	0	0	0	0	0	0	0	0	0	1
Cook Islands	Aitutaki	4	1	2	0	0	0	0	0	0	1	0	0
Cook Islands	Rarotonga	696	86	548	0	1	0	1	0	0	26	26	8
Costa Rica	San Jose	33	0	33	0	0	0	0	0	0	0	0	0
Dominican Republic	Santo Domingo	0	0	0	0	0	0	0	0	0	0	0	0
Fiji	Lautoka	37	0	24	0	1	0	0	0	2	7	2	0
Fiji	Nadi	4316	31	2733	6	5	0	3	3	301	661	550	23

Country	Port of export	Total freight	Appliances	Produce	Pharmaceuticals	Metals	Glass	Furniture	Fur	Footwear	Foodstuffs	Fibres	Other
Fiji	Savusavu	1	0	0	0	0	0	0	0	0	0	1	0
Fiji	Suva	127	5	5	0	0	0	0	0	64	17	29	7
Finland	Oulu (Uleaborg)	8	8	0	0	0	0	0	0	0	0	0	0
French Polynesia	Bora Bora	0	0	0	0	0	0	0	0	0	0	0	0
French Polynesia	Papeete	17	6	0	0	3	0	0	0	0	3	1	4
French Polynesia	Raiatea	0	0	0	0	0	0	0	0	0	0	0	0
Germany	Berlin	118	57	0	28	18	1	1	0	0	0	1	12
Germany	Berlin-Schonefeld Apt	7	0	0	4	2	0	0	0	0	0	0	1
Ghana	Accra	0	0	0	0	0	0	0	0	0	0	0	0
Guam	Guam	2	1	0	0	0	0	0	0	0	0	0	0
Haiti	Port-au-Prince	0	0	0	0	0	0	0	0	0	0	0	0
Honduras	Tegucigalpa	0	0	0	0	0	0	0	0	0	0	0	0
India	Bangalore	150	43	61	0	2	6	0	0	0	5	22	10
India	Bombay (Mumbai)	509	55	21	86	40	9	12	6	16	13	225	25
India	Calcutta	170	11	0	0	7	0	0	104	0	1	43	3
Indonesia	Jakarta, Java	312	46	4	6	55	1	6	6	13	13	131	31
Indonesia	Jakarta-Soekarno-Hatta Airpo	0	0	0	0	0	0	0	0	0	0	0	0
Indonesia	Surabaya-Tanjung Perak, Java	155	5	0	1	9	0	0	0	3	123	6	7
Jamaica	Kingston	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Akitsu, Hiroshima	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Chiba, Chiba	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Fukuoka, Fukuoka	9	5	0	0	2	0	0	0	0	0	0	2
Japan	Funabashi, Chiba	2	2	0	0	0	0	0	0	0	0	0	0
Japan	Hakata, Fukuoka	6	6	0	0	0	0	0	0	0	0	0	0
Japan	Haneda Apt/Tokyo	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Hiroshima, Hiroshima	2	1	0	0	0	0	0	0	0	0	0	0
Japan	Ikejima, Nagasaki	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Kawasaki, Kanagawa	12	11	0	0	0	0	0	0	0	0	0	0
Japan	Kikuma, Ehime	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Kumamoto, Kumamoto	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Nagasaki, Nagasaki	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Narita Apt/Tokyo	778	427	0	0	80	51	46	5	2	2	4	162
Japan	Okinawa, Okinawa	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Tokyo, Tokyo	1912	1061	0	7	284	50	37	21	1	24	24	403
Japan	Yatsushiro, Kumamoto	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Yokohama, Kanagawa	31	28	0	0	1	0	0	0	0	0	0	1
Japan	Yokoshima, Hiroshima	0	0	0	0	0	0	0	0	0	0	0	0
Kiribati	Tarawa	0	0	0	0	0	0	0	0	0	0	0	0
Kuwait	Kuwait	1	1	0	0	0	0	0	0	0	0	0	0
Malaysia	Kuala Lumpur	1660	861	1	24	282	16	40	12	5	50	154	216
Malaysia	Pasir Gudang, Johor	16	0	0	0	16	0	0	0	0	0	0	0
Malaysia	Penang (Georgetown)	1675	1569	0	1	24	0	6	20	0	20	7	27
Malaysia	Port Kelang (Port Swettenham)	16	1	0	0	12	0	2	0	0	0	0	1
Malaysia	Tanjong Pelepas	22	4	0	0	4	1	0	1	0	3	4	3

Country	Port of export	Total freight	Appliances	Produce	Pharmaceuticals	Metals	Glass	Furniture	Fur	Footwear	Foodstuffs	Fibres	Other
Mauritius	Port Louis	4	0	1	0	0	0	0	0	0	0	0	3
Moscow	Domodedovo Apt/Moscow	2	1	0	0	1	0	0	0	0	0	0	1
Nigeria	Lagos	1	0	0	0	0	0	0	0	0	0	0	0
Nigeria	Port Harcourt	0	0	0	0	0	0	0	0	0	0	0	0
Niue	Niue Island	0	0	0	0	0	0	0	0	0	0	0	0
Oman	Muscat	7	0	0	0	6	0	0	0	0	0	0	0
Palau	Koror	0	0	0	0	0	0	0	0	0	0	0	0
Panama	Colon	1	0	0	0	0	0	0	0	1	0	0	0
Panama	Panama City	0	0	0	0	0	0	0	0	0	0	0	0
Papua New Guinea	Kimbe	0	0	0	0	0	0	0	0	0	0	0	0
Papua New Guinea	Lae	0	0	0	0	0	0	0	0	0	0	0	0
Papua New Guinea	Port Moresby	7	2	0	0	0	0	0	0	0	4	0	0
Papua New Guinea	Wewak	1	0	0	0	0	0	0	0	0	1	0	0
Philippines	Manila	232	156	4	2	33	1	8	3	0	2	7	15
Puerto Rico	San Juan	50	2	0	18	1	0	0	0	2	5	0	21
Russia	Moskva (Moscow)	12	4	0	0	5	0	0	0	1	0	1	0
Samoa	Apia	265	8	179	1	1	0	0	0	0	70	3	4
Saudi Arabia	Damman	1	0	0	0	0	0	0	0	0	0	0	1
Singapore	Singapore	9844	5382	168	114	1000	105	125	71	66	278	544	1994
Singapore	Singapore Container Terminal	11	5	0	0	2	0	0	0	0	0	0	3
Solomon Islands	Honiara, Guadalcanal Island	2	0	0	0	0	0	0	0	0	1	0	0
Somalia	Mogadishu	0	0	0	0	0	0	0	0	0	0	0	0
Spain	Barcelona	385	113	0	60	59	7	21	5	9	1	78	32
Sri Lanka	Colombo	34	3	0	0	1	0	2	0	0	11	14	3
Switzerland	Zurich	934	339	0	35	103	20	11	29	4	21	49	323
Taiwan	Kaohsiung	98	14	2	0	47	0	2	1	0	8	18	7
Taiwan	Taichung	11	6	0	0	2	0	1	0	0	0	1	1
Tanzania	Dar es Salaam	1	1	0	0	0	0	0	0	0	0	0	0
Tonga	Neiafu	0	0	0	0	0	0	0	0	0	0	0	0
Tonga	Tongatapu-Nuku'alofa	149	3	23	0	0	0	0	0	0	119	0	4
Tonga	Vava'u	0	0	0	0	0	0	0	0	0	0	0	0
UK	London	1927	508	0	256	224	40	54	9	5	45	153	634
UK	London-Gatwick Apt	57	18	0	4	8	1	1	0	0	1	2	21
UK	London-Heathrow Apt	4629	1240	3	266	628	63	75	17	17	182	343	1794
UK	Stansted Apt/London	0	0	0	0	0	0	0	0	0	0	0	0
UK	Tilbury	11	6	0	1	1	0	0	0	0	0	0	3
USA	Brunswick, GA	0	0	0	0	0	0	0	0	0	0	0	0
USA	Buffalo, NY	10	4	0	0	1	1	0	0	0	0	0	4
USA	Fort Lauderdale, FL	18	11	0	0	2	0	1	0	0	0	0	3
USA	Fort Myers, FL	0	0	0	0	0	0	0	0	0	0	0	0
USA	Freeport, TX	0	0	0	0	0	0	0	0	0	0	0	0
USA	Galveston, TX	0	0	0	0	0	0	0	0	0	0	0	0
USA	Hampton-Newport News-Williams	0	0	0	0	0	0	0	0	0	0	0	0
USA	Honolulu, HI	386	185	4	3	26	4	12	4	0	14	16	118

Country	Port of export	Total freight	Appliances	Produce	Pharmaceuticals	Metals	Glass	Furniture	Fur	Footwear	Foodstuffs	Fibres	Other
USA	Houston, TX	152	68	0	1	55	0	3	0	0	0	4	21
USA	Jacksonville, FL	11	1	0	0	0	0	0	0	0	0	0	10
USA	Joplin, MO	0	0	0	0	0	0	0	0	0	0	0	0
USA	Kahului, HI	0	0	0	0	0	0	0	0	0	0	0	0
USA	Kings Bay, GA	0	0	0	0	0	0	0	0	0	0	0	0
USA	Miami, FL	63	27	2	0	4	0	3	0	1	1	2	23
USA	Minneapolis/St Paul Apt, MN	323	164	0	4	58	4	5	0	0	29	7	53
USA	New Orleans Intl Apt, LA	18	8	0	0	4	0	0	0	0	0	1	6
USA	New Orleans, LA	4	1	0	0	1	0	0	0	0	0	0	2
USA	Norfolk, VA	21	15	0	3	2	0	0	0	0	0	0	1
USA	Norfolk-Newport News, VA	0	0	0	0	0	0	0	0	0	0	0	0
USA	Orlando, FL	44	7	25	1	7	0	1	0	0	0	0	3
USA	Palm Beach, FL	0	0	0	0	0	0	0	0	0	0	0	0
USA	St Petersburg, FL	0	0	0	0	0	0	0	0	0	0	0	0
USA	Tampa, FL	33	22	0	0	2	0	1	0	0	0	0	8
USA	Texas City, TX	1	1	0	0	0	0	0	0	0	0	0	0
USA	West Palm Beach, FL	1	0	0	0	0	0	0	0	0	0	0	0
US Virgin Islands	Frederiksted, St Croix	1	0	0	0	0	0	0	0	0	0	0	0
US Virgin Islands	St Croix Island Apt	0	0	0	0	0	0	0	0	0	0	0	0
Wallis & Futuna Islands	Futuna Island	0	0	0	0	0	0	0	0	0	0	0	0

Table c. Details of the freight types that comprise each category and the categories (HS2 Chapters) used to classify incoming freight in the Statistics New Zealand database (Source: Statistics New Zealand). Description of categories provided in Table d.

Mode of transport	Type of freight	HS2 Chapters
Sea freight	Appliances and machinery	84–89
	Fibres etc	50–63
	Bulk freight	25, 27, 28, 31
	Foodstuffs	2–4, 9–23
	Furniture/toys etc	94, 95
	Furs and skins	41–43
	Glass, ceramics etc	68–70
	Metals, plastics, organic chemicals etc	72–81, 26, 29, 32, 39, 40
	Produce	6–8
	Wood based products	44–48
	Other	All remaining chapters
Air freight	Appliances and machinery	84–89
	Produce	6–8
	Pharmaceutical products	30
	Metals, plastics, organic chemicals etc	72–81, 26, 29, 32, 39, 40, 83
	Glass, ceramics etc	68–70
	Furniture/toys etc	94, 95
	Fur and skins	41–43
	Footwear	64
	Foodstuffs	2–4, 9–23
	Fibres etc	50–63
	Other	All remaining chapters

Table d. Description of categories (HS2 Chapters) used to classify incoming freight in the Statistics New Zealand database.

Categories	Description
01	Animals; live
02	Meat and edible meat offal
03	Fish and crustaceans, molluscs and other aquatic invertebrates
04	Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere specified or included
05	Animal originated products; not elsewhere specified or included
06	Trees and other plants, live; bulbs, roots and the like; cut flowers and ornamental foliage
07	Vegetables and certain roots and tubers; edible
08	Fruit and nuts, edible; peel of citrus fruit or melons
09	Coffee, tea, mate and spices
10	Cereals
11	Products of the milling industry; malt, starches, inulin, wheat gluten
12	Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit, industrial or medicinal plants; straw and fodder
13	Lac; gums, resins and other vegetable saps and extracts
14	Vegetable plaiting materials; vegetable products not elsewhere specified or included
15	Animal or vegetable fats and oils and their cleavage products; prepared animal fats; animal or vegetable waxes
16	Meat, fish or crustaceans, molluscs or other aquatic invertebrates; preparations thereof
17	Sugars and sugar confectionery
18	Cocoa and cocoa preparations
19	Preparations of cereals, flour, starch or milk; pastrycooks' products
20	Preparations of vegetables, fruit, nuts or other parts of plants
21	Miscellaneous edible preparations
22	Beverages, spirits and vinegar
23	Food industries, residues and wastes thereof; prepared animal fodder
24	Tobacco and manufactured tobacco substitutes
25	Salt; sulphur; earths, stone; plastering materials, lime and cement
26	Ores, slag and ash
27	Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes
28	Inorganic chemicals; organic and inorganic compounds of precious metals; of rare earth

Categories	Description
	metals, of radio-active elements and of isotopes
29	Organic chemicals
30	Pharmaceutical products
31	Fertilizers
32	Tanning or dyeing extracts; tannins and their derivatives; dyes, pigments and other colouring matter; paints, varnishes; putty, other mastics; inks
33	Essential oils and resinoids; perfumery, cosmetic or toilet preparations
34	Soap, organic surface-active agents; washing, lubricating, polishing or scouring preparations; artificial or prepared waxes, candles and similar articles, modelling pastes, dental waxes and dental preparations with a basis of plaster
35	Albuminoidal substances; modified starches; glues; enzymes
36	Explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations
37	Photographic or cinematographic goods
38	Chemical products n.e.s.
39	Plastics and articles thereof
40	Rubber and articles thereof
41	Raw hides and skins (other than furskins) and leather
42	Articles of leather; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silk-worm gut)
43	Furskins and artificial fur; manufactures thereof
44	Wood and articles of wood; wood charcoal
45	Cork and articles of cork
46	Manufactures of straw, esparto or other plaiting materials; basketware and wickerwork
47	Pulp of wood or other fibrous cellulosic material; recovered (waste and scrap) paper or paperboard
48	Paper and paperboard; articles of paper pulp, of paper or paperboard
49	Printed books, newspapers, pictures and other products of the printing industry; manuscripts, typescripts and plans
50	Silk
51	Wool, fine or coarse animal hair; horsehair yarn and woven fabric
52	Cotton
53	Vegetable textile fibres; paper yarn and woven fabrics of paper yarn
54	Man-made filaments
55	Man-made staple fibres
56	Wadding, felt and non-wovens, special yarns; twine, cordage, ropes and cables and articles thereof

Categories	Description
57	Carpets and other textile floor coverings
58	Fabrics; special woven fabrics, tufted textile fabrics, lace, tapestries, trimmings, embroidery
59	Textile fabrics; impregnated, coated, covered or laminated; textile articles of a kind suitable for industrial use
60	Fabrics; knitted or crocheted
61	Apparel and clothing accessories; knitted or crocheted
62	Apparel and clothing accessories; not knitted or crocheted
63	Textiles, made up articles; sets; worn clothing and worn textile articles; rags
64	Footwear; gaiters and the like; parts of such articles
65	Headgear and parts thereof
66	Umbrellas, sun umbrellas, walking-sticks, seat sticks, whips, riding crops; and parts thereof
67	Feathers and down, prepared; and articles made of feather or of down; artificial flowers; articles of human hair
68	Stone, plaster, cement, asbestos, mica or similar materials; articles thereof
69	Ceramic products
70	Glass and glassware
71	Natural, cultured pearls; precious, semi-precious stones; precious metals, metals clad with precious metal, and articles thereof; imitation jewellery; coin
72	Iron and steel
73	Iron or steel articles
74	Copper and articles thereof
75	Nickel and articles thereof
76	Aluminium and articles thereof
78	Lead and articles thereof
79	Zinc and articles thereof
80	Tin; articles thereof
81	Metals; n.e.s., cermets and articles thereof
82	Tools, implements, cutlery, spoons and forks, of base metal; parts thereof, of base metal
83	Metal; miscellaneous products of base metal
84	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof
85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, parts and accessories of such articles
86	Railway, tramway locomotives, rolling-stock and parts thereof; railway or tramway track fixtures and fittings and parts thereof; mechanical (including electro-mechanical) traffic signalling equipment of all kinds
87	Vehicles; other than railway or tramway rolling stock, and parts and accessories thereof

Categories	Description
88	Aircraft, spacecraft and parts thereof
89	Ships, boats and floating structures
90	Optical, photographic, cinematographic, measuring, checking, medical or surgical instruments and apparatus; parts and accessories
91	Clocks and watches and parts thereof
92	Musical instruments; parts and accessories of such articles
93	Arms and ammunition; parts and accessories thereof
94	Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, n.e.s.; illuminated signs, illuminated name-plates and the like; prefabricated buildings
95	Toys, games and sports requisites; parts and accessories thereof
96	Miscellaneous manufactured articles
97	Works of art; collectors' pieces and antiques
98	New Zealand miscellaneous provisions

Appendix 2: Details of BIOSECURE methodology

BIOSECURE is a computer-based decision tool for management of biosecurity risks to New Zealand's indigenous ecosystems. The model runs over Landcare Research's intranet using specifically designed software with links to databases and GIS software.

Methods

Input data

Records of species occurrence are obtained from the scientific literature, ant collections records available on the web, and from communication with various researchers. Records for an exact collection locality or relatively defined areas are predominantly used. For the mainland USA some data on county records are included (e.g., Callcott & Collins 1996) with the county seat used as the data point, and for many islands presence/absence information is all that was available. Data points are separated into those of introduced and native range. Within the introduced range, records closely associated with urban areas are identified and a separate analysis conducted excluding these data in order to separate risks associated with urban areas and heated buildings from other habitats. These data sets are submitted to BIOSECURE.

Climate summary

For each location, climate data was obtained for eight parameters (Table A2.1) from global climate surfaces based on half-degree grid square resolution. Summary data for each parameter (N, mean, minimum, maximum) are presented for native and introduced range separately.

Table A2.1: Global climate surfaces used in BIOSECURE.

Abbreviation	Climate Parameters
MAT	Annual mean of the monthly mean temperature (°C)
MINT	Mean temperature of the coldest month (°C)
MATS	Seasonality of temperature - absolute difference in mean temperature between the warmest and coldest months (°C)
PREC	Mean annual precipitation (mm)
PRECS	Seasonality of precipitation - absolute difference in mean precipitation between the wettest and driest months (mm)
VP	Annual mean of the monthly mean vapour pressure (kPa)
VPS	Seasonality of vapour pressure - absolute differences in mean vapour pressure between the most humid and the least humid months (kPa)
MAS	Annual mean of monthly mean solar radiation ($MJ/m^2/day$)

Climate similarity scores

For each climate parameter a frequency distribution of the data points is produced. The frequency distribution is then divided into 10 equal bins between the minimum and maximum values. Two additional bins of the same size are added, one above and one below the outermost values. Each bin gets a score between 1 (the additional two bins) and 100 based on the rescaled frequency of occurrence of the data within each bin (Fig. A2.1). Then all global grids are allocated a similarity (or risk) score between 0 (the climate parameters value for that grid square is outside the values in the bins) and 100.

The climate similarity scores for New Zealand are projected onto a 25 m resolution climate surface that forms part of the LENZ environmental domains (Leathwick et al. 2003).

Outlier data in each climate layer are checked. Data points are removed and the analysis re-run only if they are identified as entry errors, or the collection site was not well defined. In addition, if the outlying data point falls on the margin between two grids it is automatically allocated to a grid in the processing. If this automatic allocation results in an outlier (e.g., the grid is predominantly mountainous and has extreme temperature values) then the data are altered to move the point into the neighbouring grid.

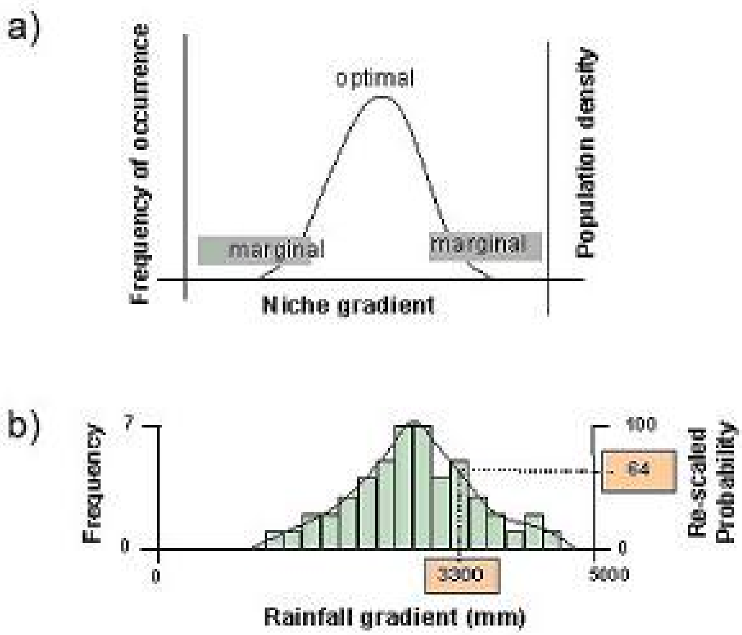

***Fig. A2.1:** Stylised representation of the conversion of input data points to similarity scores. (a) The input data are assumed to represent the niche of the species for a particular parameter. (b) The frequency distribution is divided into a series of bins across the range of the data, allowing any point on the globe to be compared with this distribution and given a similarity score from 0 (outside the range of the data) to 100 (bin with highest frequency of data = optimal climate) (figure modified from a presentation of G. Barker).*

Individual climate layers are assessed for distinctiveness between the international data and New Zealand, and presented in the results if they show a high degree of discrimination (large areas of New Zealand with no similarity or in the marginal zone relative to the international data. MAT, MINT and PREC are routinely presented to allow comparison between species).

An overall summary risk map is also presented; this represents the mean of the similarity scores of five climate layers (MAT, MINT, PREC, VP, PRECS). This presentation approximates the summary map produced by the risk assessment tool Climex.

Appendix 3: Summary of current known distribution and BIOSECURE analysis for two ant species already established in New Zealand.

Linepithema humile is widely distributed in northern New Zealand while *Pheidole megacephala* is restricted to Auckland despite being established since the 1940s (Fig. A3.1).

Prediction of New Zealand range for Linepithema humile *(Argentine ant)*

Native range data for this species overlap with northern New Zealand for MAT. MINT shows similarity for a greater area, but still within northern New Zealand. MAS shows low similarity with New Zealand. The other parameters show some discrimination within New Zealand. The introduced range greatly extends the areas of similarity of New Zealand, as the ant has become widely distributed globally, particularly in areas of anthropogenic disturbance. Large areas of the North Island and the northern South Island show overlap for MAT (Fig. A3.2), and all other parameters show greater overlap. For many areas where temperature parameters show high similarity, there is marginal similarity for rainfall (at the high end), which may restrict its distribution (Fig. A3.2).

For MAT the climate in the native + introduced non-urban sites still shows considerable overlap with New Zealand (Fig. A3.3). However, this may be overstated as 3 cold outliers, from native habitat in Chile (Snelling 1975) contribute to the overlap of MAT across southern New Zealand, but these records could be another species, as the taxonomy of *Linepithema* in South America is in need of revision (A. Wild, pers. comm.).

Predictions of New Zealand range for Pheidole megacephala *(big-headed ant)*

Native range data suggests most of New Zealand is too cold for *Ph. megacephala*, with overlap for MAT only for the far north of the North Island. This overlap results from a single record from grassland by a highway in Pietermaritzburg, South Africa (Samways et al. 1997). The native + introduced range suggests potential range overlap with Northern NZ for MAT (Fig. A3.4), which results principally from urban records, from Sana'a in Yemen (Collingwood & Agosti 1996), and from an imprecise record from "central Spain" (Collingwood 1978). Most of the North Island and coastal South Island is within the range of data for MINT. Precipitation is too high in south-western and alpine areas, and these areas are too cold (Fig. A3.4). Other climate parameters are highly suitable across much of New Zealand.

For the native + introduced (non-urban range), MAT overlap is minimal (Fig. A3.5), and caused only by the single point from Pietermaritzburg, South Africa. Overlap of MINT is reduced but there is still overlap for large areas of northern New Zealand. Results for the other climate parameters are the same as for the analysis of native + introduced range.

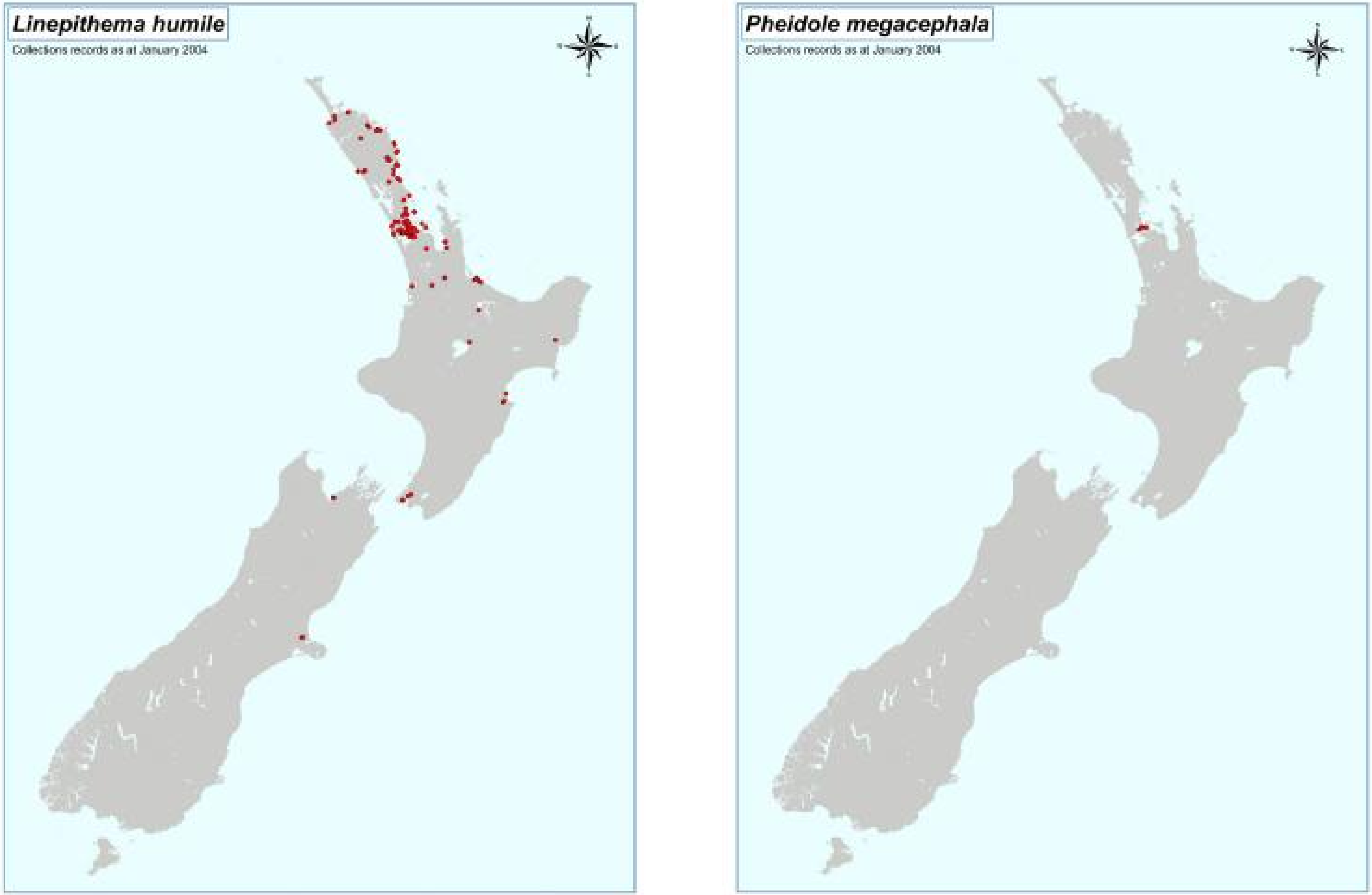

Fig. A3.1: *New Zealand sites where* L. humile *and* Ph. megacephala *are known to be established.*

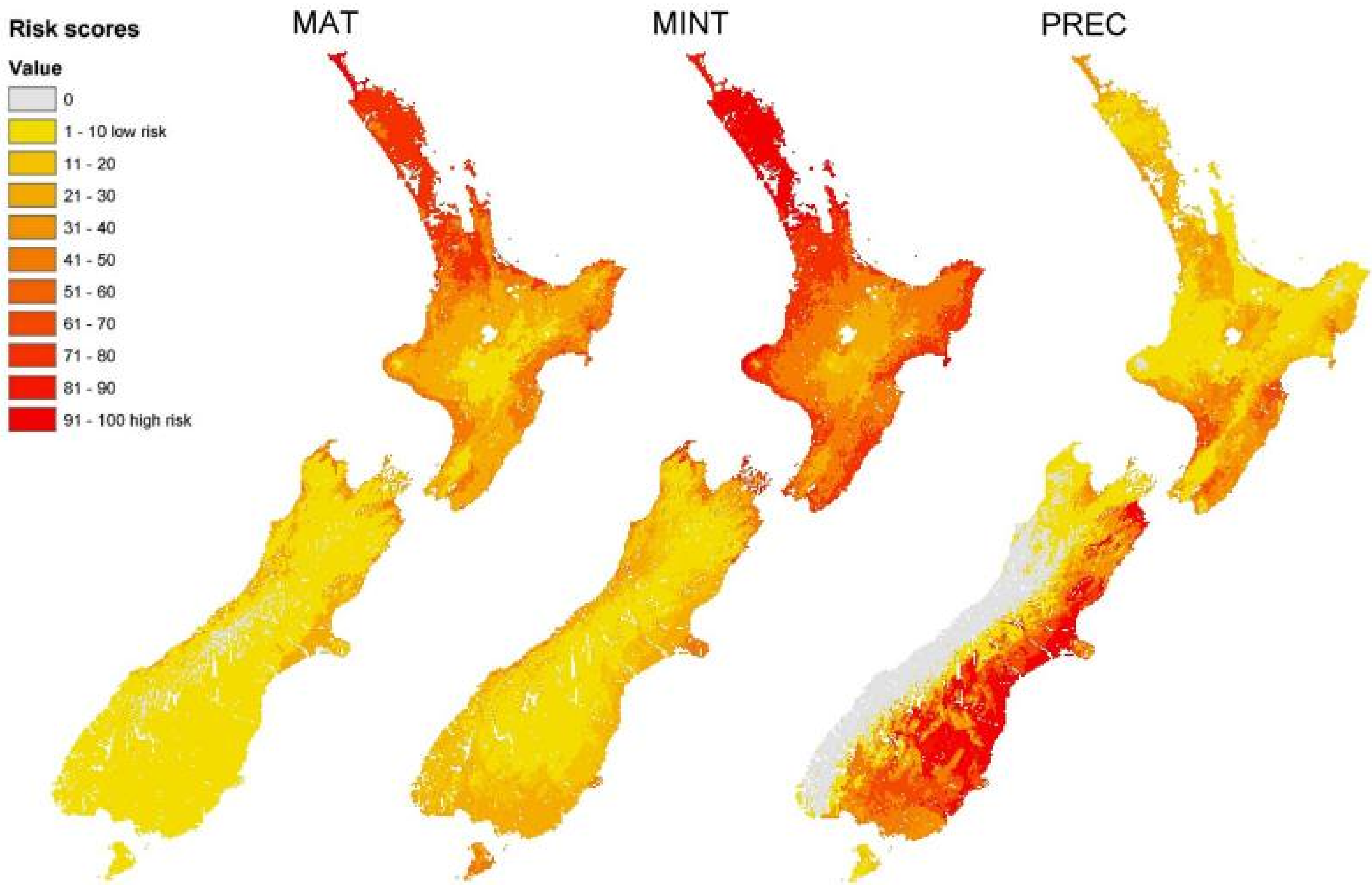

Fig. A3.2: *Similarity of native + introduced ranges of* L. humile *to New Zealand for MAT, MINT and PREC.*

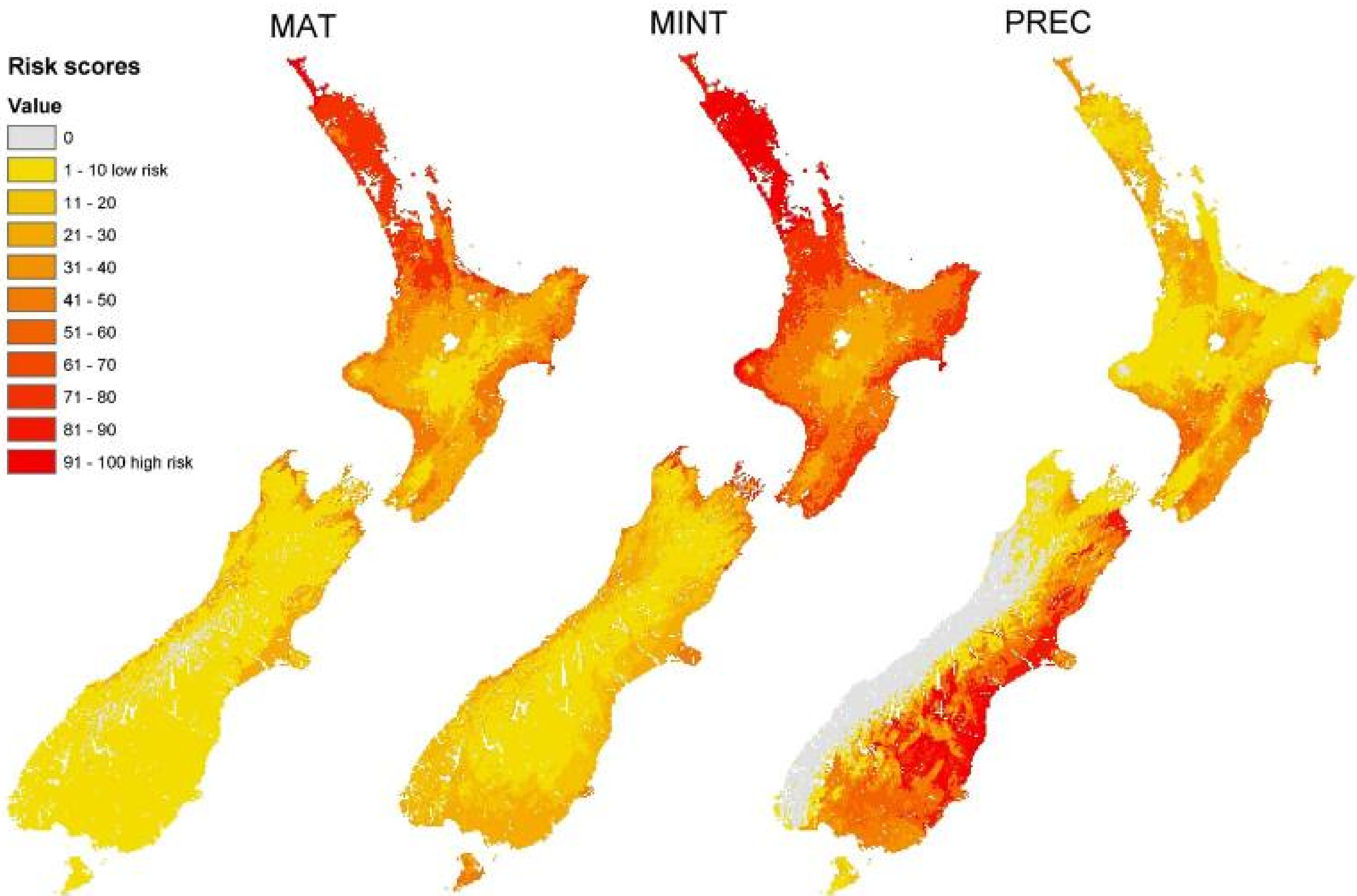

Fig. A3.3: *Similarity of native + non-urban introduced ranges of* L. humile *to New Zealand for MAT, MINT and PREC.*

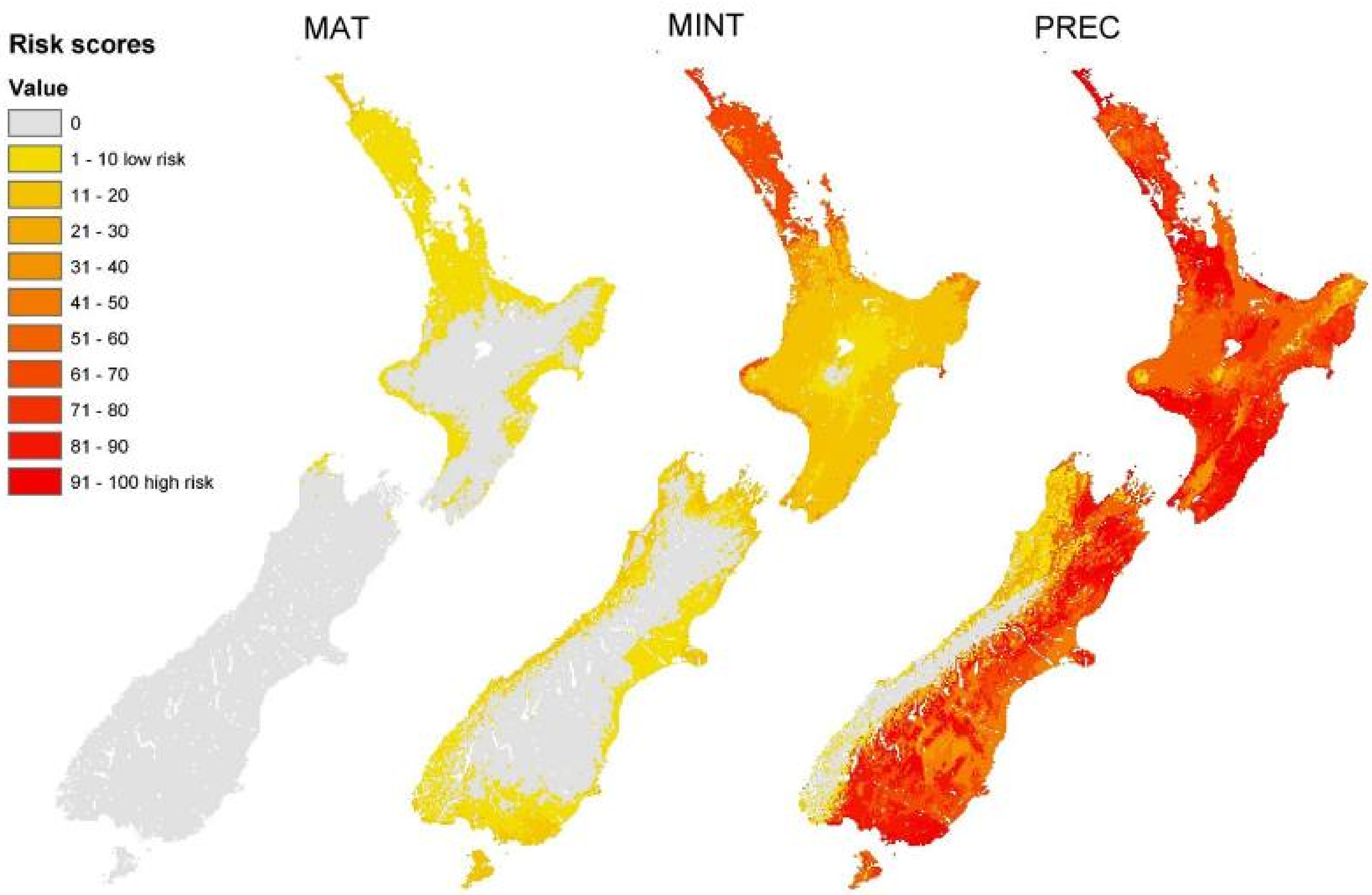

Fig. A3.4: *Similarity of native + introduced ranges of* Ph. megacephala *to New Zealand for MAT, MINT and PREC.*

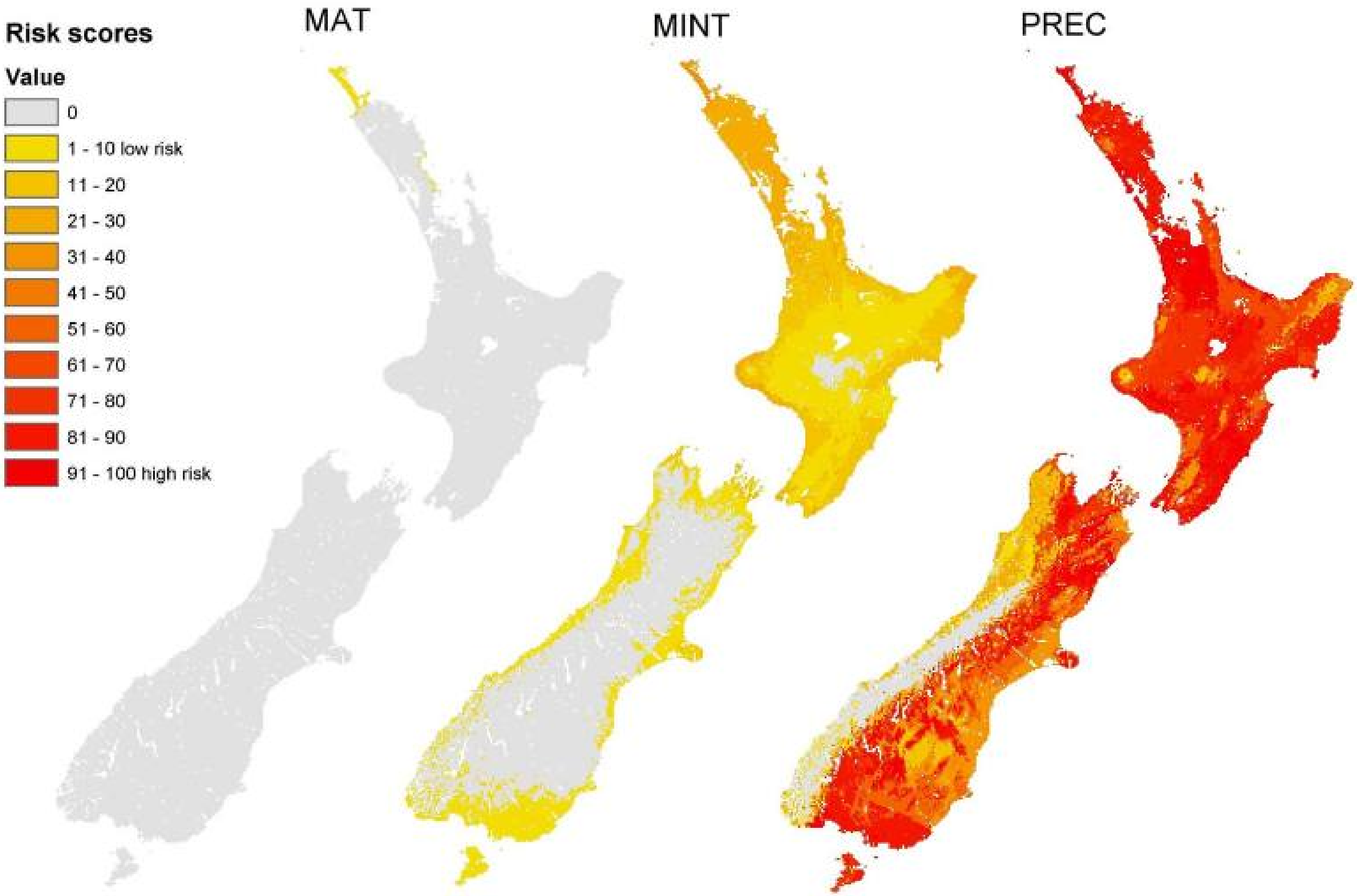

Fig. A3.5: *Similarity of native + non-urban introduced ranges of* Ph. megacephala *to New Zealand for MAT, MINT and PREC.*