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## Revision of the species of the *Iridomyrmex conifer* group (Hymenoptera : Formicidae), with notes on their biology

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### Abstract

The *conifer* species-group of the ant genus *Iridomyrmex* is defined and revised at the species level. The species *I. conifer* Forel, *I. setoconus*, sp. nov. and *I. turbineus*, sp. nov. are placed in the group, which is limited to south-western Australia. A key to species is provided and distributions are summarised. These ants show unusual nesting habits in that thatched mounds are used during the cooler winter months and subterranean nests are constructed during the hot summer months. This habit is not known to occur in any other ant. These ants are opportunistic feeders utilising a variety of food sources and will readily relocate nest sites in response to changing resources.

### Introduction

The ant genus *Iridomyrmex* was recently redefined and its status within the subfamily Dolichoderinae clarified (Shattuck 1992a, 1992b). Unfortunately, the species-level classification within the genus is currently poorly understood and identifications are difficult. In the present study the *I. conifer* species-group is revised. Three species are recognised in the group, all of which are limited to south-western Australia. The species are morphologically similar, differing primarily in the development of pilosity on the head and mesosomal dorsum.

Biologically, these ants are some of the most unusual in *Iridomyrmex*. One species, *I. conifer*, has been studied in detail by one of us (PM) and the results of these studies are presented below. It was found that this species uses two distinct nest types: above-ground thatched mounds (Fig. 5) and subterranean nests. Climatic factors influence the type of nest occupied, with mound nests constructed during cooler periods and below-ground nests used during warmer periods.

Previous investigations on these ants have been limited. Chemical compounds produced were examined by Cavill *et al.* (1956) and Blum *et al.* (1978), and beetles (20 species in 10 families) that occur in *I. conifer* nests were reported by Clark (1923). Clark (1921) and Crawley (1922) comment on nest structure and Crawley (1922) also mentions these ants preying on lepidopterous larvae.

### Methods and abbreviations

#### *Pilosity characters*

The abundance and placement of pilosity was found to be of value in diagnosing species within the *I. conifer* group. However, it should be noted that these hairs are easily abraded and therefore caution should be used when examining older specimens or when limited amounts of material are available.

#### *Morphometric characters*

Size and shape characters were quantified and are reported as lengths or indices. Measurements were made with a stereo microscope using a dual-axis stage micrometer wired to digital readouts. All

measurements were recorded in thousandths of millimetres, but are expressed here to the nearest hundredth. All head measurements (EL, EW, HL, HW) were taken in full-face (dorsal) view without moving the head between measurements. Longitudinal mesosomal length measurements (PnL, ML, PpL) were taken in lateral view, parallel to a line ('measuring axis') drawn between the anterior-most point of the pronotal collar and the posterior-most point of the propodeal process dorsal of the petiolar insertion.

Figures showing the following measurements can be found in Shattuck (1993): EL, EW, HL, HTL, HW, ML, PnL, PpL and SL.

#### *Abbreviations used*

##### *Morphometric characters*

CI	Cephalic index: HW/HL
EL	Maximum eye length measured in full face view
EW	Maximum eye width measured in full face view
HL	Maximum head length in full face view, measured from the anterior-most point of the clypeal margin to the midpoint of a line drawn across the posterior margin of the head
HTL	Maximum length of hind tibia, excluding the proximal part of the articulation that is received into the distal end of the hind femur
HW	Maximum head width in full face view, excluding eyes
ML	Mesonotal length measured from the pronotal-mesonotal suture to the metanotal groove parallel to the measuring axis (see also above)
PnL	Pronotal length measured from the anterior edge of the pronotal collar to the pronotal-mesonotal suture parallel to the measuring axis (see also above)
PpL	Propodeal length measured from the metanotal groove to the posterior-most point of the petiolar insertion parallel to the measuring axis (see also above)
REL	Relative eye length: EL/HW
SI	Scape index: SL/HW
SL	Length of the scape (first antennal segment) excluding the basal radicle

##### *Collectors*

BBL	B. B. Lowery
JC	J. Clark
JDM	J. D. Majer
JEF	J. E. Feehan
PSW	P. S. Ward
PM	P. McMillan
RWT	R. W. Taylor
SOS	S. O. Shattuck
TG	T. Greaves

##### *Collections*

ANIC	Australian National Insect Collection, Canberra, Australian Capital Territory
BMNH	The Natural History Museum, London, UK
JDMC	J. D. Majer, Perth, Western Australia, personal collection
MCZC	Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA
MHNG	Museum d'Histoire Naturelle, Geneva, Switzerland
SAMA	South Australian Museum, Adelaide, South Australia
WAMP	Western Australian Museum, Perth, Western Australia

##### *Biological observations*

Investigations on the biology of the *I. conifer* group were conducted by one of us (PM). These studies were conducted over a number of years and examined the nesting, foraging and reproductive biology of *I. conifer*. The research was undertaken at the University of Western Australia's Harry Waring Marsupial Reserve at Munster, comprising 253 ha of coastal bushland on Bassendean soils (McMillan 1982).

### Taxonomic status of *Iridomyrmex* and diagnosis of species-group

#### Diagnosis of the *Iridomyrmex conifer* group

For the current status and identification of *Iridomyrmex* see Shattuck (1992a, 1992b). The *I. conifer* species-group, here proposed for the first time, contains one previously described species (*I. conifer* Forel) and two newly described taxa (*I. setoconus* and *I. turbineus*). The group can be diagnosed by the configuration of the greatly expanded propodeum, which extends dorsally to form a distinctive triangular projection (Figs 2, 10, 13). This condition is unique and will readily separate these ants from other members of the genus *Iridomyrmex*.

#### Key to species of the *Iridomyrmex conifer* species-group

Based on workers.

1. Erect or suberect hairs generally absent from pronotum, but when present never more than 6 (Fig. 2) ..... *I. conifer*  
More than 8 erect or suberect hairs present on the pronotum (Figs 10, 13) ..... 2
2. Lateral margin of head (in full face view) generally lacking erect hairs, but when present the posterior hairs longer than the maximum scape diameter and distinctly curved (Fig. 12).....  
..... *I. turbineus*, sp. nov.  
Lateral margin of head (in full face view) always with numerous short (less than maximum scape diameter), straight or very slightly curved erect hairs (Fig. 9) ..... *I. setoconus*, sp. nov.

#### *Iridomyrmex conifer* Forel

(Figs 1–8)

*Iridomyrmex conifer* Forel, 1902: 463. – Forel, 1907: 297 (description of queen); Crawley, 1922: 26 (description of male); Wheeler & Wheeler, 1974: 398 (description of larva).

*Iridomyrmex 'conifer'* sp. A. – Andersen & Burbidge, 1992: 44.

*Iridomyrmex 'conifer'* sp. C. – Andersen & Burbidge, 1992: 44.

#### Material examined

*Types.* Five worker syntypes, Perth, Western Australia (3 in MHNG, 2 in ANIC).

*Other material.* (In ANIC unless otherwise noted.) **Western Australia:** 11 mi WNW of Esperance (TG); 13 km NW of Esperance (RWT); 13 km W of Hopetoun, Fitzgerald R. Natl Pk, 33°56'07"S, 119°59'43"E (SOS); 15 km WSW of Israelite Bay, 33°41'16"S, 123°43'03"E (SOS); 19 mi E of Esperance (TG); 19 mi E of Ongerup (TG); 20 km S of Condingup, 33°55'34"S, 122°34'39"E (SOS); 28 km WSW of Israelite Bay, Cape Arid Natl Pk, 33°42'40"S, 123°36'15"E (SOS); 30 km NE of Esperance, 33°49'S, 122°14'E (RWT); 31 km NW of Hopetoun, Fitzgerald R. Natl Pk, 33°50'13"S, 119°49'08"E (SOS); 32 km S of Dwellingup, 33°00'S, 116°05'E (I. D. Naumann and J. C. Cardale); 32 km SW of Mt Ragged, 33°39'S, 123°13'E (RWT); 34 mi WSW of Ravensthorpe (TG); 36 km N of Eneabba (PM) (WAMP); 3 km SW of Mt Ragged (RWT); 3 km WSW of Mt Ragged (RWT); 40 km SE of Ravensthorpe, 33°39'S, 120°27'E (RWT); 40 km SSW of Borden, Stirling Range Natl Pk, 34°24'04"S, 118°06'02"E (SOS); 52 km W of Israelite Bay, Cape Arid Natl Pk, 33°44'42"S, 123°19'34"E (SOS); 5 km W of Mt Ragged (RWT); 62 km NE of Albany, Hassell Natl Pk, 34°37'43"S, 118°23'10"E (SOS); 80 mi E of Esperance (BBL); 85 km SE of Ravensthorpe, 33°44'S, 120°56'E (RWT); 9 mi W of Israelite Bay (TG); Albany (TG); Banganup (PM) (WAMP); Barrens Beach, Fitzgerald R. Natl Pk, 33°56'S, 120°03'E (SOS); Canning Vale (B.Heterick) (JDMC); Cape Arid (PM) (WAMP); Cape Le Grand, nr Esperance (E. O. Wilson) (MCZC); Duans Rocks Beach, 14 km S of and 45 km E of Esperance (M. S. Upton); Esperance (BBL, PM, E. O. Wilson) (ANIC, MCZC, WAMP); Fitzgerald R. Natl Pk (PM) (WAMP); Forrestdale (PM) (WAMP); Frenchman Peak, Cape Le Grand Natl Pk, 33°58'00"S, 122°10'01"E (SOS); Gleneagle, 32°15'S, 116°10'E (J. Springett); Gold Holes, Stirling Range (RWT); Gora (as Goora) Hill (TG); Inlet Camp, Stokes Natl Pk, 33°49'08"S, 121°08'52"E (SOS); Israelite Bay (TG; SOS); Jandakot (PM) (WAMP); Junana Rock, 9 km NW of Mt Ragged, 33°23'S, 123°24'E (RWT); Jurien Bay (C. Chubb) (JDMC); Kalamunda (TG); Karragullen, 32°05'S, 116°08'E (PSW); Kings Pk, Perth (P. J. Darlington; W. M. Wheeler) (MCZC); Lime Lake (PM) (WAMP); Lucky Bay, Cape La Grande (PM) (WAMP); Moingup Spring, Stirling Range Natl Pk, 34°24'S, 118°06'E (PSW); Mt Ragged, 33°28'S, 123°28'E (RWT); Pearce (A. Douglas); Peelhurst, 32°26'S 115°45'E (PM) (WAMP); Perth (Chase; JC; TG) (ANIC, MCZC); Point (as Port) Malcolm (A. M. and M. J.

Douglas); Roleystone (J. Beasley) (WAMP); Russell, Jandakot (PM); Seal Creek, Cape Arid Natl Pk (A. H. Burbidge); Starvation Boat Harbour, 33°56'S, 120°33'E (SOS); Subiaco (collector unknown) (MCZC); Swan R. (JC, S. J. Clark) (ANIC, MCZC, SAMA); Thomas R. (N. R. Mitchell); Thomas R., 23 km NW by W of Mt Arid, 33°51'S, 123°00'E (JEF); Watning (PM) (WAMP); Yandil (W. M. Wheeler) (MCZC); c. 8 km NE of Thomas R. Station, E Esperance (E. O. Wilson and C. P. Haskins) (MCZC).

#### *Worker diagnosis*

Erect or suberect hairs generally absent from pronotum, but when present never more than 6; lateral margin of head (in full face view) lacking erect or suberect hairs.

#### *Description*

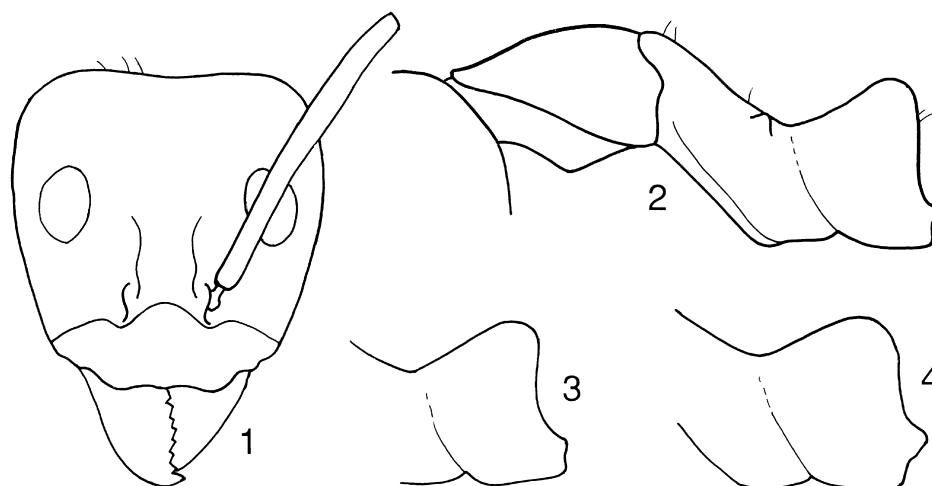
Head varying from uniform brown with the anterior regions of the clypeus and mandibles slightly lighter, to brown with the anterior regions (including clypeus), mandibles and scapes yellowish red; dorsal pronotum, anterior mesonotum and dorsal propodeum brown, the posterolateral pronotum, lateral and posterior mesonotum and lateral and ventral propodeum yellowish red; and petiole, gaster and legs brown. Elongate erect hairs generally absent from lateral margin of head (Fig. 1) and mesosomal dorsum (Fig. 2), occasionally with up to 18 on posterior margin of head, 6 on pronotum and 6 on propodeum; gula and first gastral tergite with or without erect hairs; scapes, legs and petiolar dorsum without erect hairs. Propodeum with anterior and posterior faces straight (Fig. 2), or weakly to strongly concave (Fig. 3).

#### *Measurements*

*Worker* ( $n = 21$ ). CI 0.95–1.05; EL 0.23–0.29; EW 0.13–0.18; HL 1.08–1.35; HTL 1.51–1.90; HW 1.05–1.38; ML 0.53–0.77; PnL 0.60–0.76; PpL 0.58–0.79; REL 0.20–0.25; SI 0.95–1.10; SL 1.13–1.35.

#### *Comments*

*Iridomyrmex conifer* has a disjunct distribution with two separate populations: one restricted to a narrow region of the Western Australian coast from Israelite Bay west to Albany, and the other in the vicinity of Perth with a single record further north at Jurien Bay and another further



**Figs 1–4.** *Iridomyrmex conifer* worker: (1) full face view (syntype); (2) lateral view of mesosoma (syntype); (3) lateral view of propodeum (specimen from Israelite Bay, Western Australia); (4) lateral view of propodeum of *I. conifer* worker (specimen from 5 km W of Mt Ragged, Western Australia).



Fig. 5. Mound nest of *Iridomyrmex conifer* (Lucky Bay, Western Australia, May, 1977, P. McMillan).

south near Dwellingup (Fig. 8). All records are less than approximately 50 km from the coast, with the majority less than 30 km. The most inland records are from the Stirling Range and near Ongerup. While detailed studies are lacking, casual observation suggests that these ants are restricted to sandy soils. This is especially noticeable in the Stirling Range where soil types vary noticeably over short distances and nests are found only on sandy soils.

The disjunction in the range of *I. conifer* corresponds strongly with the distribution of the closely related species *I. turbineus* (see below and compare Figs 8 and 11). The western limit of the eastern population of *I. conifer* is Albany while the eastern limit of *I. turbineus* is at Mettler Lake, south-east of Wellstead. Thus these species overlap by less than 50 km and only about 10 of the 169 collection records of both species occur in this overlap region. Similarly, the western population of *I. conifer* and the north-western limit of *I. turbineus* meet near Dwellingup in a narrow zone of sympatry. These distribution patterns suggest that interactions between these species might be affecting their distributions but detailed studies will be needed to determine whether this or some other factor is responsible.

The specimens considered to represent the single species *I. conifer* in this study show variation in several morphological traits. The most noticeable of these is the shape of the propodeum in lateral profile. The anterior and posterior faces of the propodeum vary from being straight to concave, with the posterior face showing greater variation than the anterior face (Figs 2–4). This variation causes the propodeum to be noticeably broader in those individuals with straight faces and narrower in individuals with concave faces. To quantify this variation, two measurements were taken: (i) the angle between the dorsal regions of the anterior and posterior faces of the propodeum, and (ii) the length of the propodeum measured along a line connecting the metanotal groove with the posterodorsal-most point immediately dorsal of the petiolar insertion. It was originally thought that these specimens could be separated into two discrete sets, one with a broad propodeum and the other with a narrow propodeum. Unfortunately, analysis of the angle measurements did not support this separation as the measurements form a single, continuous, approximately normal distribution (Fig. 6).

To determine whether the angular variation affected other aspects of propodeal morphology, the angle was plotted against the length of the propodeum. It was thought that this might show, for example, whether more sharply angular propodeal dorsums occurred in individuals with shorter mesosomas (as measured by propodeal length). As shown in Fig. 7, no correlation was found between these two traits. It appears that the angle is simply a function of the degree of curvature of the propodeal faces and not other (obvious) mesosomal modifications. Additionally, the range of angle values found within these specimens was about the same as that found within the closely related species *I. turbineus*. This suggests that the variation in propodeal angle is intraspecific rather than interspecific and therefore all collections are considered to represent a single species, *I. conifer*.

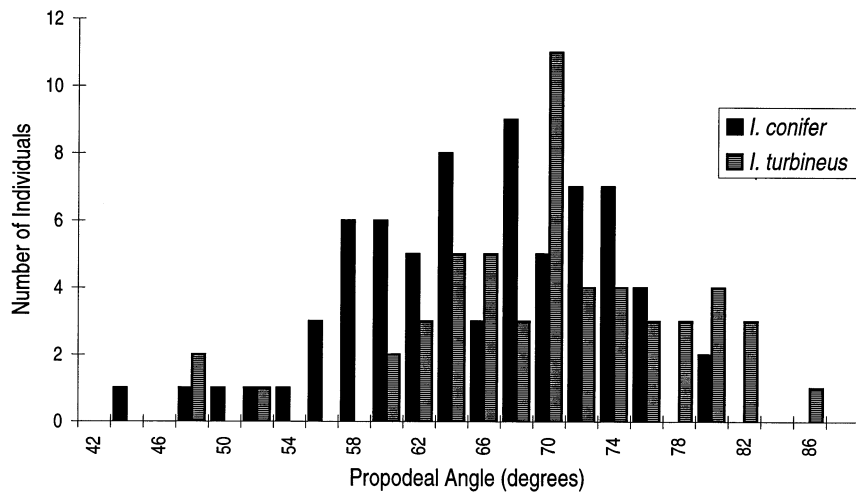


Fig. 6. Distribution of propodeal angle values among *Iridomyrmex conifer* and *I. turbineus* workers.

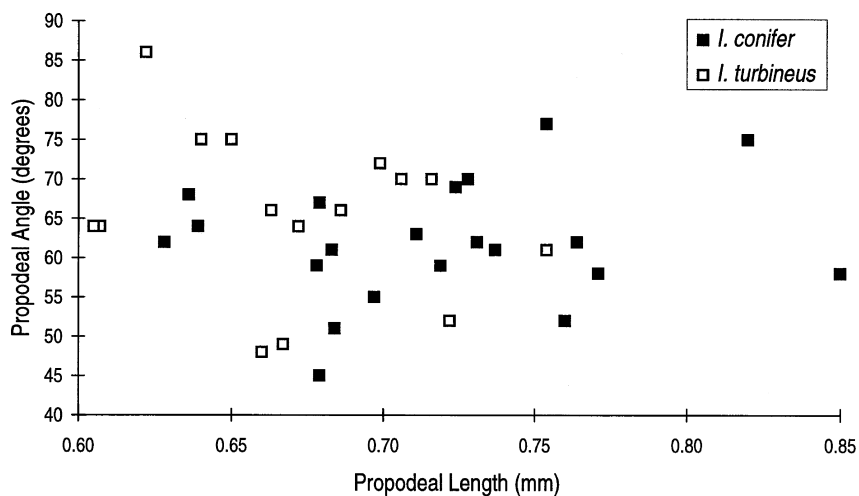


Fig. 7. Distribution of propodeal angle versus propodeal length among *Iridomyrmex conifer* and *I. turbineus* workers.

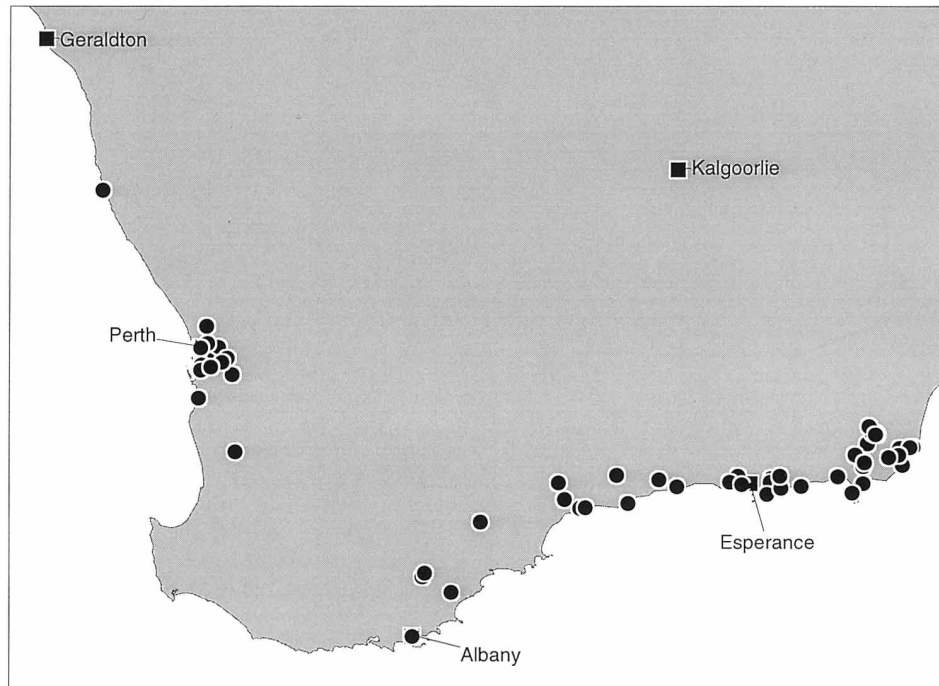


Fig. 8. Distribution of *Iridomyrmex conifer* specimens examined during this study.

In addition to the propodeal shape, another trait was found that varies significantly among individuals. Most workers lack elongate, erect or suberect hairs on the gula, but in some individuals numerous hairs are present. This trait is weakly correlated with the shape of the propodeum, with more hairs generally found on workers with broader propodeal angles and fewer or no hairs on workers with more strongly angular propodeums. However, as with the propodeal angle, the amount of variation in this trait is large and the above-mentioned correlation is weak, with numerous exceptions found in the material examined during this study. Therefore there is no evidence to suggest that more than one species is involved.

*Iridomyrmex setoconus*, sp. nov.

(Figs 9–11)

*Iridomyrmex* 'conifer' sp. B. – Andersen & Burbridge, 1992: 44.

*Material examined*

*Holotype.* Worker, Western Australia, Yokinup Bay, Cape Arid Natl Pk [c. 33°52'S, 123°02'E], June 1988, A. H. Burbridge (ANIC, type no. 7989).

*Paratypes.* 54 workers, same data as holotype (ANIC, BMNH, MCZC, WAMP).

*Other material.* **Western Australia:** Thomas R. (PM) (ANIC, WAMP).

*Worker diagnosis*

More than 8 erect or suberect hairs present on the pronotum; lateral margin of head (in full face view) with numerous short, erect hairs. *Iridomyrmex setoconus* is similar to *I. turbineus* in the development of erect body hairs. The two species may be separated in that *I. setoconus*



always possesses erect hairs on the lateral margin of the head (in full face view), while *I. turbineus* often lacks these hairs. Separation from individuals of *I. turbineus* that have erect hairs on the lateral head margin is based on differences in hair morphology. In *I. setoconus*, the hairs are straight (or very slightly bent basally) and are relatively short (less than the maximum scape diameter), while those in *I. turbineus* are strongly curved and longer (greater than the maximum scape diameter). Additionally, the hairs in *I. setoconus* are usually evenly distributed along the entire outer head margin while those in *I. turbineus* are unevenly distributed, often with irregular gaps between individual hairs.

#### Description

Head fading gradually from brown posteriorly to yellowish red anteriorly, and with mandibles and scapes yellowish red; dorsal pronotum, anterior mesonotum and dorsal propodeum brown, the posterolateral pronotum, lateral and posterior mesonotum and lateral and ventral propodeum yellowish red; petiole, gaster and legs brown. Erect hairs present on all surfaces of head (Fig. 9), mesosomal (Fig. 10) and petiolar dorsum, first gastral tergite and legs; erect hairs absent from scapes. Propodeum with anterior and posterior faces straight (Fig. 10).

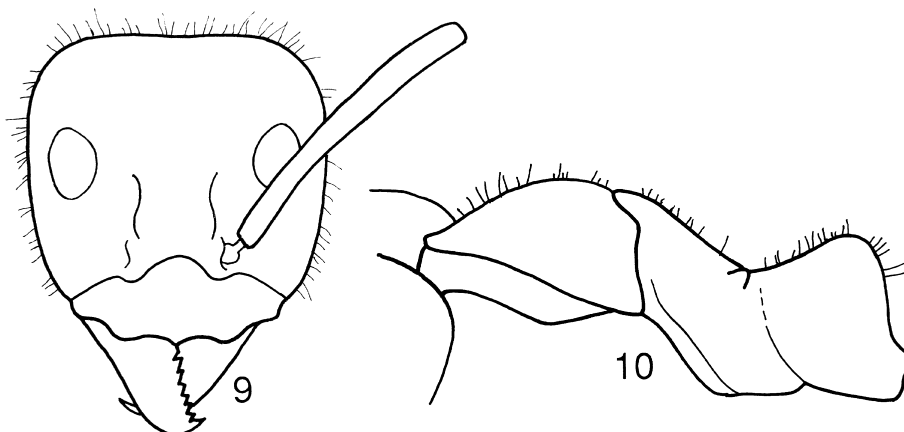
#### Measurements

*Holotype.* CI 0.98, EL 0.25, EW 0.15, HL 1.15, HTL 1.60, HW 1.13, ML 0.57, PnL 0.63, PpL 0.65, REL 1.02, SI 1.03, SL 1.16.

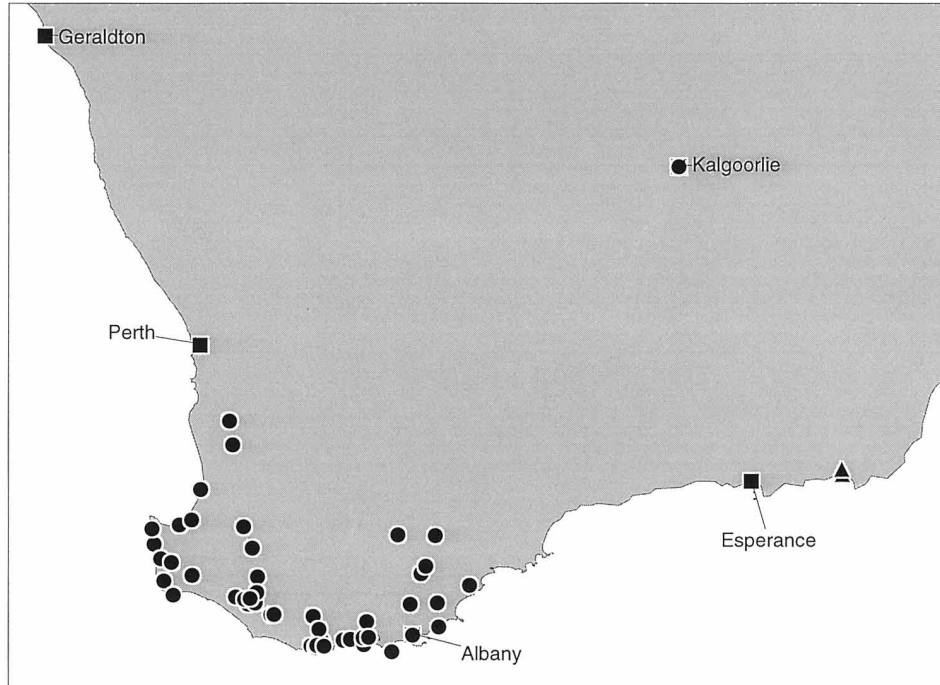
*Worker* ( $n = 4$ ). CI 0.94–1.00; EL 0.24–0.27; EW 0.15–0.17; HL 1.10–1.17; HTL 1.53–1.67; HW 1.04–1.17; ML 0.52–0.61; PnL 0.63–0.69; PpL 0.59–0.68; REL 0.23; SI 0.99–1.08; SL 1.12–1.16.

#### Comments

*Iridomyrmex setoconus* is known from two collections. The first is an above-ground nest found on a sand dune at Thomas River and the second is from a pitfall trap set at Yokinup Bay, Cape Arid National Park. This second collection was made during a survey of the ant fauna of that region (Andersen and Burbidge 1992) (Fig. 11). During this study, 15 pitfalls were placed at three separate sites within Cape Arid National Park on a variety of soil and vegetation types. The sole record of *I. setoconus* came from the only pitfall placed on calcareous sand soils, which was



**Figs 9, 10.** Full face view (9) and lateral view of mesosoma (10) of *Iridomyrmex setoconus* worker (holotype).



**Fig. 11.** Distribution of *Iridomyrmex setoconus* (▲) and *I. turbineus* (●) specimens examined during this study.

only one of two sites with dune shrubland vegetation. As both of the known collections were made on sandy soils it is likely that this species may be limited in the types of soils on which it can survive. This would support similar observations of soil specificity observed in *I. conifer* (see above).

*Iridomyrmex turbineus*, sp. nov.

(Figs 11–13)

*Material examined*

*Holotype.* Worker, Western Australia, 5 km S of Dwellingup, 33°45'S, 116°04'E, S. O. Shattuck (SOSC #3047) (ANIC, type no. 7990).

*Paratypes* 29 workers, same data as holotype (ANIC, BMNH, MCZC, WAMP).

*Other material.* (In ANIC unless otherwise noted.) **Western Australia:** 10 mi E of Northcliffe (RWT); 10 mi S of Yallingup (E. F. Riek); 11 mi N of Denmark (RWT); 19 mi N of Walpole (RWT); 1 km W of Walpole, Walpole–Nornalup Natl Pk, 35°00'20"S, 116°43'13"E (SOS); 26 km S of Dwellingup, 32°57'S, 116°04'E (I. D. Naumann and J. C. Cardale); 29 km E of Karridale (Sues Rd), 34°09'22"S, 115°24'01"E (SOS); 30 mi NE of Albany (TG); 5 km S of Dwellingup, 33°45'S, 116°04'E (SOS); 5 mi N of Pemberton (W. M. Wheeler) (MCZC); 6 km W of Pemberton, 34°27'07"S, 115°58'14"E (SOS); 7 km N of Hamlin Bay, Leeuwin–Naturaliste Natl Pk, 34°10'47"S, 115°04'46"E (SOS); 7 km NE of Walpole, 34°57'S, 116°48'E (PSW); 8 mi E of Northcliffe (RWT); Albany (TG); Augusta (W. S. Brooks; BBL; JDM) (ANIC, JDMC, MCZC); Beedelup Falls, nr Pemberton (M. S. Upton); Boat Harbour W of Denmark (PM.) (WAMP); Borden (TG); Bornholm Cliffs, 20 km W of Denmark (PM) (WAMP); Bridgetown (W. M. Wheeler) (MCZC); Bunbury (BBL); Busselton (JC); Coalmine Beach, Walpole–Nornalup Natl Pk, 34°59'S, 116°44'E (J. and N. Lawrence); Denmark (TG, BBL, PM) (ANIC, WAMP); Dwellingup (JDM) (JDMC);

Gnangara (PM) (WAMP); Kalgoorlie (P. Aitken); Kenton, nr Mt Mehniup (RWT); Lights Beach, Denmark (PM); Ludlow (JC); Manjimup (JDM) (JDMC); Margaret R. (W. M. Wheeler) (MCZC); Mettler Lake, SE of Wellstead (B. Heterick) (JDMC); Mt Clare, 4 mi W of Walpole (RWT); Mt Frankland, N of Walpole (RWT); Mt Shadforth, Denmark (PM) (WAMP); Mt Toobrunup, Stirling Range (N. Dobrotworsky); Mt Trio, Stirling Range (RWT); Nornalup (JDM; PM) (JDMC, WAMP); Pemberton (S. Clarke) (WAMP); Perry's Beach, Denmark (PM) (WAMP); Porongurup Natl Pk (RWT); Rosa Glen, nr Margaret R. (W. M. Wheeler) (MCZC); S. M. Q. Forest Dept, Walpole (PM) (WAMP); Stirling Range (PM); Tingledale, W of Denmark (PM) (WAMP); Toolbrunup, Stirling Range (RWT); Two People Bay, 34°57'S, 118°11'E (J. Springett); Walpole (BBL); Walpole Natl Pk., Nut Rd, W of Denmark (PM) (WAMP); Waterfall Beach, William Bay Natl Pk, 35°01'29"S, 117°15'30"E (SOS); West Cape Howe Natl Pk (PM) (WAMP); Yallingup (Austin) (MCZC); nr Mt Frankland, N of Walpole (RWT); nr Pemberton, 34°30'S, 115°05'E (J. Springett); nr Warren R., 10 km S of Pemberton (D. K. McAlpine).

#### *Worker diagnosis*

More than 8 erect or suberect hairs present on the pronotum; lateral margin of head (in full face view) generally lacking erect hairs. Separation of individuals of *I. turbineus* that have erect hairs on the lateral head margin from individuals of *I. setoconus* is based on differences in hair placement, size and shape. In *I. turbineus* the posterior hairs are strongly curved, greater in length than the maximum scape diameter, and all hairs are unevenly distributed along the outer margin of the head and often with irregular gaps between individual hairs. In *I. setoconus* the hairs are straight (or very slightly bent basally), relatively short (less than the maximum scape diameter) and evenly distributed along the entire outer head margin.

#### *Description*

Body colour varies from uniform yellowish red (with a darker gaster) to uniform brown, with intermediate individuals possessing a mosaic pattern as follows: posterior regions of head brown and anterior regions (including clypeus), mandibles and scapes yellowish red; dorsal pronotum, anterior mesonotum and dorsal propodeum brown, the posterolateral pronotum, lateral and posterior mesonotum and lateral and posterior propodeum yellowish red; petiole, gaster and legs brown in all forms. Elongate erect hairs present on posterior margin (and often lateral margin) of head (Fig. 12), gula, mesosomal (Fig. 13) and petiolar dorsum, and first gastral tergite; legs with or without erect hairs; scapes without erect hairs. Propodeum generally with the anterior and posterior faces straight (Fig. 13), occasionally with the posterior face weakly concave.

#### *Measurements*

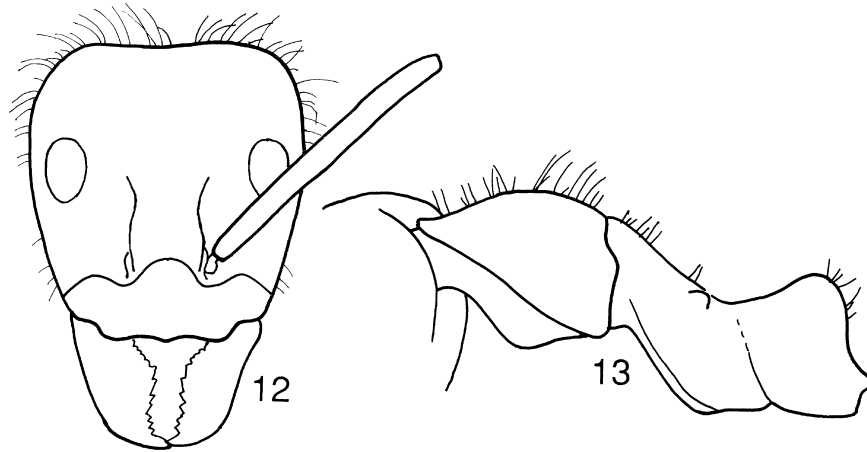
*Holotype.* CI 0.96, EL 0.27, EW 0.18, HL 1.13, HTL 1.66, HW 1.08, ML 0.54, PnL 0.66, PpL 0.64, REL 0.25, SI 1.08, SL 1.17.

*Worker* ( $n = 15$ ). CI 0.96–1.01; EL 0.24–0.27; EW 0.15–0.18; HL 1.09–1.36; HTL 1.53–1.88; HW 1.05–1.37; ML 0.53–0.70; PnL 0.55–0.80; PpL 0.56–0.76; REL 0.20–0.25; SI 0.96–1.08; SL 1.09–1.35.

#### *Comments*

*Iridomyrmex turbineus* is only known from a narrow zone of coastal south-western Western Australia from approximately Dwellingup south and east to Borden (Fig. 11). As occurs in *I. conifer*, all collection localities are within 50 km of the coast and the majority are within 30 km. The range of this species seems to disrupt that of *I. conifer*, as they show only a slight overlap in the Stirling Range and vicinity, and near Dwellingup (Figs 8, 11; and see *I. conifer* above).

There are also two records from inland areas that require comment. The first is five workers in the ANIC labelled 'Kalgoorlie, 29 Nov., 1960, P. Aitken, collected at light', and the second is two records from the West Angelas area near Hamersley Range National Park (c. 23°11'S, 118°46'E) reported by Majer (1983, p.34). The first of these locations is some 500 km from the main range of *I. turbineus* while the second is over 1000 km distant. Given the narrow



**Figs 12, 13.** Full face view (12) and lateral view of mesosoma (13) of *Iridomyrmex turbineus* worker (holotype).

geographic distribution of the majority of collections of this species-group, and the apparent specialised habitat requirements, it seems probable that these two records represent mislabelled series rather than extant populations. Additionally, one of us (PM) spent several days attempting to confirm the record from the Hamersley Range without success. This throws further doubt on this record.

Morphologically, *I. turbineus* is fairly uniform throughout its range, although it does show a slight reduction in the amount of pilosity in western areas and noticeable colour variation as described above.

#### **Biology of the *I. conifer* species-group**

The following observations were made on *I. conifer*. Casual observations suggest that similar patterns occur in *I. turbineus* although detailed observations have yet to be completed. Nothing is known about the biology of *I. setoconus*.

#### *Nest structures used by I. conifer*

*Iridomyrmex conifer* shows the unusual and apparently unique nesting habit of utilising two distinct nest types on a yearly cycle. During cooler winter months, above-ground thatched mounds are constructed (Fig. 5), while during the hot summer months nests are subterranean and without superstructures. These habits were first noted by Clark (1921) and Crawley (1922) but detailed studies of life history and general and reproductive biologies have only recently been completed and are reported here for the first time (see also McMillan 1982).

Mound nests are constructed using a range of available vegetation including grasses, rushes, *Casuarina* cladodes and small twigs ranging from 0.5 to 10 cm in length, as well as whole dead leaves of *Baeckia camphorosmae*, *Kunzea ericifolia*, *Melaleuca preissiana* and leaf fragments of *Banksia* species. These materials are interspersed with sand grains varying in size from 0.5 to 1.5 mm. The specific materials used vary from site to site. Thus ants in areas dominated by *Casuarina fraseriana* build mounds of *Casuarina* cladodes, while those situated in areas dominated by *Banksia* species use small leaves or pieces of leaves. Additionally, only new materials are used as ants were never seen using vegetation from deserted mounds.

Occupied, undisturbed mounds are minimally affected by rain and appear to be waterproofed externally, possibly by worker-produced glandular secretions. During construction, workers

were seen to touch the mound surface with the underside of their mandibles and move their heads from side to side. In occupied mounds workers are continually 'plastering' the outer surfaces and these have a polished look. In contrast, vacated mounds are susceptible to water penetration and in heavy rain soon became wet throughout.

Subterranean nests without superstructures, which can be up to 60 cm below the ground surface, are typical of subterranean ant nests in general and consist of a number of chambers connected by passageways. Multiple entrance holes are typically found in a cleared, saucer-shaped area on the surface above the nest and their number increases with the age and size of the nest.

#### *Movement between mound and underground nests*

Field observation shows that in late spring or early summer, with a rise in maximum daily temperature above 20°C for 2–5 days, ants begin to excavate underground nests (Fig. 14). These new nests are often near the current mound nest and close to a suitable food source (see below), and they increase in size during the summer with an enlargement of the cleared area above the nest and an increase in the number of entrance holes. In autumn, with a fall in maximum daily temperature below 20°C over a period of 2–5 days, ants begin to build above-ground mound nests.

A prolonged drop in summer temperatures can induce mound construction. An example of this behaviour was observed from 13 to 26 December 1980, when maximum temperatures remained below 15°C. By 22 December a small mound had been constructed above the underground nest. By 27 December, when the temperature had risen to 25°C, the mound was vacated and the ants returned to the underground nest.

Laboratory experiments were undertaken to confirm the influence of temperature on the type of nest constructed. Ants were transferred to a controlled temperature room with an 8 h light : 16 h dark cycle. Temperature was varied between 22°C and 38°C while relative humidity was held constant at 60%. The ants constructed mound nests when temperatures were 22°C or less, and

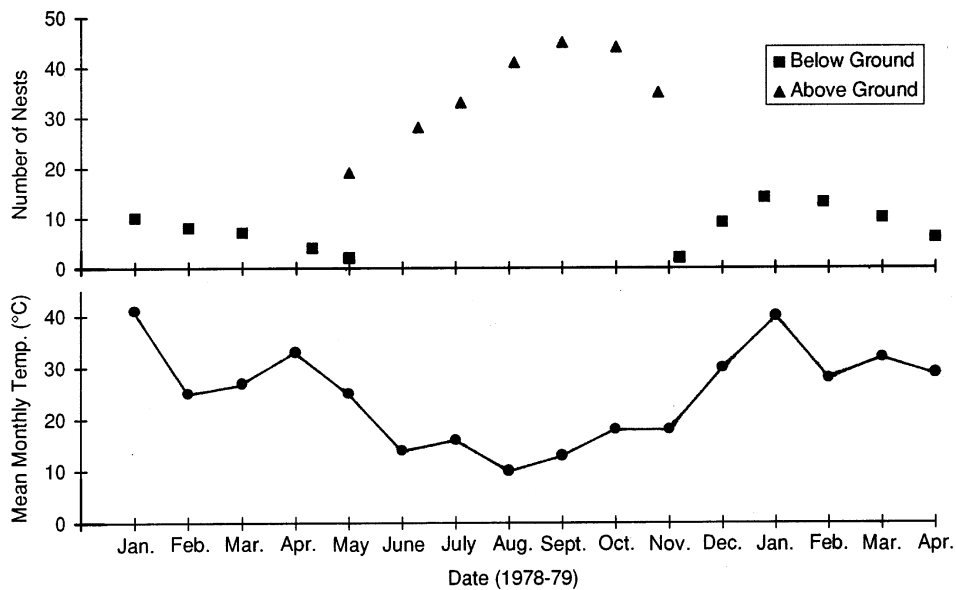


Fig. 14. Nest building in relation to temperature in *Iridomyrmex conifer* under field conditions.

began construction of underground nests when the temperature was increased to 38°C. When temperature was returned to 20°C the ants again began to utilise mound nests (Fig. 15). During the period of this experiment (conducted during December) control colonies located in the field were occupying underground nests.

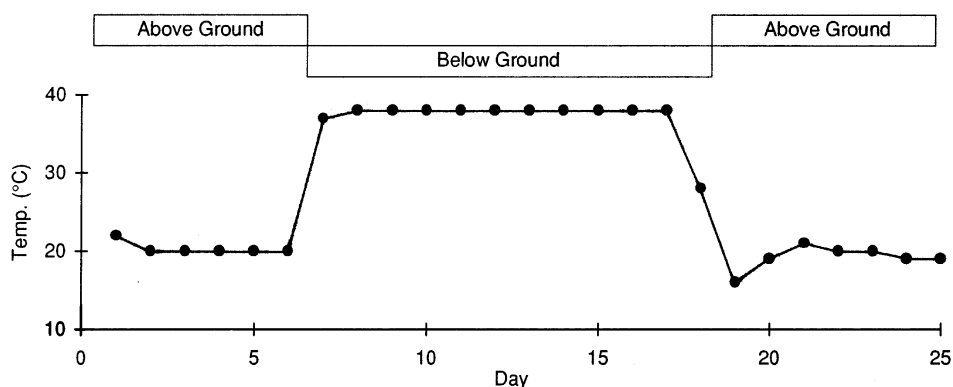
*Iridomyrmex conifer* always selects underground nest sites within a suitable foraging distance of a food source and usually in shady, sheltered areas. Workers have never been observed foraging from underground nests on trails more than 1 m long. Underground nests are associated with trees, low shrubs or succulents with various Homoptera (e.g. *Eurymela fenestrata* Lepelletier & Serville, *Pulvinariella mesembryanthemi*, *Ourococcus casuarinae*) present. As these insects act as a food source (see below) and do not migrate, *I. conifer* will remain in these nests for extended periods. However, if the food source is destroyed the ants will move to another suitable site and build a new nest. An example of this occurred when ants moved from an established nest to a new one 40 m away in a patch of *Carpobrotus edulis* after a bushfire destroyed their previous foraging area.

Winter mound nests are always constructed in open, sunny positions with northern exposures. In these positions they gain maximum solar radiation. These nests are built at greater distances from food plants than are summer nests and can be up to 12 m from foraging areas.

Budding of mound nests can occur if there is an abundant food supply. This was observed on several occasions. In one instance, workers were foraging to a *Banksia menziesii* with many flowers. The parent nest remained active from 7 July to 23 August, during which time two new nests were formed. The ants in these new mounds foraged to new food sources separate from the parental nest and each other. Ants in the original parental nest switched to foraging on nearby *Ourococcus casuarinae* when nectar from the original *Banksia menziesii* flowers was no longer available. Later, ants from the parental nest moved to a new location at a fresh nectar source on a *Banksia ilicifolia*. This indicates that dispersal to a new nest site takes place when a food source is depleted. Ants feed continually during winter and foragers constantly seek fresh nectar-producing flowers throughout this period.

#### Feeding and foraging behaviour

Adults of *I. conifer* are primarily nectar feeders and actively forage on suitable blossoms. A wide variety of plants are utilised, including species of *Banksia*, various members of the Myrtaceae, and *Xanthorrhoea preissii*. These sources are preferred throughout the year, even when sap-sucking insects are present.



**Fig. 15.** Nest building in relation to temperature in a single nest of *Iridomyrmex conifer* under controlled conditions.

During the day *I. conifer* was often seen foraging on flowers together with *Crematogaster laeviceps* and *Dolichoderus* sp. At no time was antagonism noted between these three species. The food being sought by *Crematogaster laeviceps* was apparently pollen as ants were usually seen on the anthers. The food of *Dolichoderus* sp. was not determined, although they were seen to forage in the same areas as *I. conifer*. They were, however, never seen at the same specific location at the same time as *I. conifer* and would move away if *I. conifer* foragers approached.

*Iridomyrmex conifer* actively associate with Homoptera, utilising them as a source of honeydew when nectar is low or not available. This switch to Homoptera often occurs during periods of low flower production or during and after drought or fire when nectar flow is low. Members of the homopteran families Aphididae, Coccidae, Eriococcidae, Eurymelidae and Psyllidae are commonly tended by these ants.

The interactions between *I. conifer* and other ant species when sap-sucking insects were involved were different from the interactions at flowers. Honeydew-producing insects were used exclusively by *I. conifer* during the day, with *Dolichoderus* sp. and *Camponotus* sp. being actively excluded from the area. At night these same honeydew insects were tended by *C. testaceipes*.

In addition to plant-derived fluids, *I. conifer* was observed transporting a variety of other foods into nests. Insect remains were the most frequent, along with oligochaete worms. Additionally, ants were seen removing particles from the remains of two small lizards (*Hemiergis* sp. and *Lerista* sp.) and a honeyeater. In the latter case, pieces of feather were also transported to the nest.

As in many ants, foraging behaviour in *I. conifer* is influenced strongly by temperature. The highest rate of foraging activity occurs between 22 and 32°C. When temperatures rise above 32°C the number of outward-bound foragers decreases and the number of inward-bound foragers increases. All foraging ceases above 40°C, normally between 1100 and 1600 hours at the study site during summer, and foragers were seldom seen away from nests or foraging areas during the hottest time of the day. Workers that had not returned to the nest during these high-temperature periods remained on the food plant.

Long foraging trails were uncommon during summer. The only trails longer than 1 m were those between nest sites, and ants moved along such trails only when temperatures were between 15 and 40°C. Observation of trails formed when moving nest sites revealed small shafts up to 15 cm deep at intervals of approximately 1 m. When temperatures approached 40°C ants using these trails stopped and moved into the shafts. The shafts apparently act as refuges from high temperatures.

Temperature and rate of movement were found to be related. Observations on long winter foraging trails showed that ants increase their rate of movement with an increase in temperature. This was particularly noticeable on sunny days, when ants foraged to food trees when surface temperatures were above 12°C. On dull days without direct sun, if the temperature did not rise above 12°C, the ants remained in the area of the nest and moved in a slow, lethargic manner. It appears that solar radiation is an important factor in determining foraging activity in winter.

#### *Reproductive behaviour*

Nuptial flights have not been observed in *I. conifer* and they apparently do not occur. Fertilisation of queens probably takes place in nests or on the nest surface; this is supported by the frequent observation of winged males alighting on nests. Nest budding seems to be the normal method of colony founding. Colonies are established at new food sources, and a fertile, dealate female together with one or more alate queens move to the new nest from the parental nest. These new nests are also provided with large numbers of workers along with larvae and pupae. Established nests commonly contain a single fertile queen along with two or three non-reproductive queens, which are often alate. Larvae and pupae are present throughout the year. Males of *I. conifer* are capable of flying reasonable distances as specimens have been collected in a suction trap located 600 m from the nearest known colonies of *I. conifer*.

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