

Distribution of the introduced ponerine ant *Pachycondyla senaarensis* (Hymenoptera: Formicidae) in Iran

Omid PAKNIA

Abstract

Pachycondyla senaarensis is the most common ant in the savannah regions of Sudan. Its habit of eating seeds has been described as unique within Ponerinae. *Pachycondyla senaarensis* was reported from Saudi Arabia in 1985 and from the United Arab Emirates in 1997 (a recent introduction). This stinging ant was recorded in southern Iran in 2004 and is now spreading rapidly into most human settlements. The distribution of *P. senaarensis* in Iran was studied through field surveys and examination of museum specimens. The species is currently limited to the southern provinces of Sistan-Baluchestan, Kerman, Fars, Hormozgan, and Bushehr with Jiroft City representing the northernmost extension of the species' range worldwide.

Key words: *Pachycondyla senaarensis*, Formicidae, introduced species, distribution, Iran.

MSc. Omid Paknia, Department of Biology, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, P.O. Box: 49165-15739, Iran. E-mail: paknia@gau.ac.ir; opaknia@yahoo.com

Introduction

Introduced ants (i.e., ants brought to new environments by humans) are represented by at least 147 species in 49 genera (MCGLYNN 1999). Introduced ants originate from all world regions and today occur in many areas outside their original ranges. Many introduced ants remain confined to human-modified habitats and some of these species are often referred to as "tramp" ants (PASSERA 1994). Another group of introduced ants are invasive ants. Invasive ants differ from most other introduced ants in several key respects, but especially in that they penetrate natural ecosystems where they often reduce native ant diversity and affect other organisms both directly and indirectly (HOLWAY & al. 2002). Although the competitive displacement of native ants by invasive ants is the most widely reported effect of ant invasions (HÖLLDOBLER & WILSON 1990, WILLIAMS 1994), they have many additional consequences. Given the variety of ecological roles filled by native ants, it seems likely that reductions in native ant diversity and abundance would indirectly affect many different taxa (HOLWAY & al. 2002). Invasive ants tend to share some general characteristics such as unicoloniality, polymorphic workers and omnivorous diet (HOLWAY & al. 2002). Because they are widespread, abundant and aggressive, one would predict that invasive ants would disrupt invaded communities (DIAMOND & CASE 1986, PIMM 1991, PARKER & al. 1999).

Pachycondyla (Brachyponera) senaarensis (MAYR, 1862), the "Samsun ant", is probably the most common ant in savannah regions of Sudan (LENIEUX & DIOMANDE 1978). It has been recorded from Senegal, Guinea, Sierra Leone, Ghana, Ethiopia, Congo, Zaire, Nigeria, and Cameroon (TAYLOR 2005). It has been described as unique among ponerines in its seed-eating habits (LACHAUD & DEJEAN 1994). Colony formation proceeds more rapidly than that of many other ponerines (DEJEAN & LACHAUD 1992). Colony foundation is generally carried out by a single queen, but some cases of multi-queen associations have been observed and it is likely that young, newly fertilized queens can return to their natal or neighboring nest to brood (DE-

JEAN & LACHAUD 1994). The average total number of adults in colonies in native regions is about 1200 (DEJEAN & LACHAUD 1994). LEVIEUX & DIAMANDE (1978) reported that there are large differences in worker sizes between colonies, depending on microhabitat differences. DEJEAN & LACHAUD (1994) reported size polymorphism within a single colony.

Pachycondyla senaarensis was reported from Saudi Arabia in 1985 (COLLINGWOOD 1985) and then from Kuwait, Oman and Yemen (COLLINGWOOD & AGOSTI 1996). It was reported as an aggressive introduced ant in the United Arab Emirates in 1997 (COLLINGWOOD & al. 1997). DIB & al. (1995) reported anaphylactic shocks in humans following stings from *P. senaarensis* in the United Arab Emirates. AKBARZADEH & al (2004) recorded this species from Iranshahr County in southeastern Iran and TIRGARI & PAKNIA (2005) reported it from Lar County in southern Iran. They found that *P. senaarensis* has established only in urban and rural areas and is closely tied to human activity in Lar County. Because of their ability to sting, these ants have medical importance (TIRGARI & al. 2004). The biology and ecology of this species in introduced regions are not clear, and it is difficult to predict its future range. In this paper I present data on the current distribution of *P. senaarensis* in Iran.

Material and methods

The survey of *P. senaarensis* distribution in Iran was carried out from June 2002 to July 2004 through examination of museum specimens and through field collecting. Specimens were examined from the Zoological Museum of Gorgan University (ZMGU), the ant collections of the Pest Management Research Institute (PMRI), and the Museum of Medical Entomology in Tehran University of Medical Sciences (METU).

Field collecting was limited to 30 towns, with special emphasis placed on southern Iran, from which all previous Iranian *P. senaarensis* records stemmed. From a list of all

250 towns in the southern provinces of Khuzestan, Bush-ehr, Fars, Sistan and Baluchestan, Kohkiluyeh Boyer-Ahmad, Hormozgan, and Kerman, 24 were randomly selected for sampling. In addition, six towns were randomly selected from a list of 50 towns in other parts of the country. In each of the resulting 30 towns, 30 transects 200 m in length were defined, resulting in a total of 900 transects. Transects were situated in irrigation ditches, roadside plantations, gardens, parks, damp ground areas, or areas around buildings. Each transect was examined for 30 to 45 minutes. Searches were conducted during daylight and consisted of scanning the ground and turning stones to find colonies and foraging workers of *P. sennaarensis*. Though searches focused on urban habitats, in each town two natural habitats were chosen outside human environments and in each of these four 500 m transects were examined. Searches at each of the latter transects lasted between 60 and 70 minutes. *Pachycondyla sennaarensis* specimens were collected directly by forceps, preserved in 70 % ethanol and deposited in ZMGU. Specimens were identified using the key in COLLINGWOOD & AGOSTI (1996), and then sent to Dr. Brian Taylor for confirmation of the identification.

Results

In total, 9477 museum specimens were examined and 28 specimens of *P. sennaarensis* were found. A total of 169 specimens were collected in the field. See Tab. 1, Fig. 1.

No specimens of *P. sennaarensis* were found among 654 ant specimens examined in the PMIRI collection. Seventeen worker specimens of *P. sennaarensis* were found among the 123 ant specimens examined in the METU collection. They had been collected from urban habitats in Iranshahr City (14 specimens) and Kahnuj City (3 specimens). Eleven worker specimens of *P. sennaarensis* were found among 8700 specimens checked in the ZMGU collection. These specimens had been collected in urban and rural areas of Bandar Abbas, Jiroft, Iranshahr and Tang Khor.

Field Collection: A total of 169 *P. sennaarensis* specimens were collected from three sites in southern Iran: Lar, Lamerd and Bandar Kangan. 146 specimens were collected from Lar City, of which six were alate queens or males. All specimens in Lar and Lamerd were collected from human settlements. Two workers were collected outside of human environments in sandy ground near a beach in Bandar Kangan, and three alates were also collected from Bandar Kangan. Nests of *P. sennaarensis* were found in each of these three locations. All specimens were collected on the ground.

Discussion

Biogeographic transfer: Like many transferred ants, *P. sennaarensis* has spread to subtropical regions, but in this case there are climatic differences between native and non-native regions. The native habitat of *P. sennaarensis* is the hot, wooded savannahs of Sudan, which are composed mainly of *Combretum* and *Terminalia* shrub and marked by a long and severe dry season. The region is flat, mainly lying between 200 m and 1000 m in altitude. The climate is tropical and strongly seasonal. Mean monthly maximum temperatures range from 30 to 33 °C and mean minimum temperatures are 18 - 21 °C. Annual rainfall is as high as 1000 mm in south and 600 mm in the north. In contrast, desert and xeric shrublands with less than 35 mm annual



Fig. 1: Map of Iran. Location of *P. sennaarensis* records from museums (quadrate shapes) and from field collecting (solid circles) are indicated and numbered as in Tab. 1. Solid triangles are localities reported by AKBARZADEH & al. (2004). Hollow circles indicate localities where *P. sennaarensis* was not found.

rainfall (MANDAVILLE 1986) cover most parts of the Arabian Peninsula. Moreover, the Persian Gulf desert and semi-desert region, which is the part of the peninsula nearest to southern Iran, is characterized by long, hot, rainless summers. Average regional rainfall is about 75 mm, with a maximum temperature of 35 °C (BUNDY & al. 1989). *Pachycondyla sennaarensis* has spread to the subtropical Nubio-Sindian desert and semi-desert region in southern Iran. This region has a climate similar to the Persian Gulf desert region, with hot summers (maximum temperatures 43 °C) and about 100 mm annual rainfall. It is clear that no part of the native range of *P. sennaarensis* has a dry and warm climate. How could *P. sennaarensis* tolerate these climatic differences? For most introduced ant species, the climate of the introduced range approximately matches that of the native range (HOLWAY & al. 2002), but there are some exceptions. In cold temperate climates that appear unsuitable for most introduced ants, such ants occur only around human habitations (TABER 2000, SUAREZ & al. 2001). Similarly, in the Arabian Peninsula and Iran *P. sennaarensis* is limited to urban areas (see COLLINGWOOD & al. 1997, TIRGARI & PAKNIA 2005), in contrast to populations in native habitats. This species can probably tolerate unsuitably warm and dry climates only when it occurs in human environments. In such places ants can make colonies near water resources, in humid soils such as in gardens, parks and along the irrigation ditches of roadside plantations (TIRGAI & PAKNIA 2005). The low rainfall in desert and semi-desert areas of the Arabian Peninsula and southern Iran is probably the principal reason for the restriction of *P. sennaarensis* to urban areas. Although *P. sennaarensis* was found outside of human environments in Bandar Kangan, this was near a beach in sandy soil which may have had sufficient humidity for colonization.

Transition to Ominivory: To date, 23 ponerine species have been recorded as introduced ants (MCGLYNN 1999).

Tab. 1: Locations where *P. sennaarensis* has been collected in Iran; dates, coordinates, altitudes (alt.), and number of specimens (n) are given. Numbers 9, 10, and 11 were reported by AKBARZADEH & al. (2004).

no.	date	collection site	location	latitude	longitude	alt.	n
1	XI.2002	Iranshahr	roadside plantation	27° 12' N	60° 41' E	570 m	14
2	IX.2001	Kahnuj	house	27° 58' N	57° 45' E	497 m	3
3	29.VII.2002	Bandar Abbas	house	27° 11' N	56° 17' E	10 m	4
4	9.XI.2002	Jiroft	garden	28° 41' N	57° 45' E	704 m	4
5	10.II.2004	Tang khor	roadside plantation	27° 26' N	53° 11' E	494 m	3
6	11.VI.2002	Lar	irrigation ditch	27° 41' N	54° 20' E	915 m	146
7	15.II.2003	Lamerd	park	27° 19' N	53° 10' E	425 m	15
8	11.II.2003	Bandar kangan	roadside plantation & near beach	27° 81' N	52° 08' E	23 m	8
9	2002 - 2003	Khash	–	28° 13' N	61° 12' E	1410 m	–
10	2002 - 2003	Sarbaz	–	26° 40' N	61° 11' E	350 m	–
11	2002 - 2003	Nik shahr	–	26° 13' N	60° 12' E	450 m	–

Five *Pachycondyla* species are in this list and these are "specialist predators" in the functional group classification of ANDERSEN (1997). However, *P. sennaarensis* is an "opportunistic" ant: it has an omnivorous diet, especially in the vicinity of human habitations (LACHAUD & DEJEAN 1994), and has a highly flexible opportunistic feeding strategy which allows it to adapt to environmental changes. One of the most striking traits of *P. sennaarensis* is its ability to use seeds as a food source (LACHAUD & DEJEAN 1994), a behavior which has been observed in Iran (TIRGARI & PAKNIA 2005) and United Arab Emirates (COLLINGWOOD & al. 1997). It appears that the evolutionary transition from carnivory, as typical of the majority of ponerine ants, to an omnivorous diet including seed consumption has had an important role in the dispersal of this species across the African continent (LACHAUD & DEJEAN 1994). Omnivory probably is likewise contributing to the dispersal of this species in non-native ranges.

Dispersal: Humans have an important role in transporting introduced ants to new regions. Most widespread ants have been introduced as a result of human commerce (HOLWAY & al. 2002). While *P. sennaarensis* has alate queens which engage in nuptial flights, winged dispersal of female reproductive forms does not appear to have played an important role in the spread of *P. sennaarensis* to non-native regions. This species has crossed two seas (the Red Sea and the Persian Gulf), so it seems that human commerce and human constructions (such as irrigation of roadside plantations, gardens and parks) are the dominant means for its spread (COLLINGWOOD & al. 1997).

There has been no investigation of the effects of introduction of *P. sennaarensis* to non-native areas. Preliminary studies show that it has high relative abundances of foraging workers (about 43 % of all ants in Lar City) in non-native areas (PAKNIA 2002). However, the Iranian areas now inhabited by *P. sennaarensis* had not been investigated in detail prior to the introduction so it is difficult to assess potential changes.

Prior to this study, the northernmost record of *P. sennaarensis* had been Lar City (27° 41' N) (TIRGARI & PAKNIA 2005), but a new record of this species from Jiroft City (28° 41' N) represents the new northernmost distribution of this species. However, this is probably not the final distribution limit of this species in Iran. Prediction of the final distribution of *Pachycondyla sennaarensis* is not possible without a greater knowledge of the species' fundamental niche (including temperature and humidity extremes).

According to the definitions of HOLWAY & al. (2002), *P. sennaarensis* should currently be considered a "tramp ant" in Iran. However, it shares several characteristics with invasive ants, such as worker polymorphism, omnivory, and unicoloniality. It may well be that its current limitation to human-modified environments is only temporary.

Acknowledgements

I wish to thank Dr. Brian Taylor for confirmation of species identifications, including comparison with type material, and for taxonomical comments, and Chris Schmidt for linguistic improvements. Paul Krushelnycky, an ano-

nymous referee, and the editors made helpful comments on the manuscript.

Zusammenfassung

Pachycondyla senaarensis ist die häufigste Ameise in den Savannen des Sudan. Die Art ernährt sich unter anderem granivor, was innerhalb der Ponerinen als einzigartig gilt. *Pachycondyla senaarensis* wurde 1985 aus Saudi-Arabien gemeldet, und 1997 aus den Vereinigten Arabischen Emiraten, wobei es sich hier um eine junge Einschleppung handelt. Im Jahr 2004 wurde die stechende Ameise aus dem südlichen Iran gemeldet, wo sie sich jetzt rasch in den meisten menschlichen Siedlungsgebieten ausbreitet. Die vorliegende Arbeit berichtet anhand von Feldstudien und Bestimmungen von Museumsmaterial über die aktuelle Verbreitung von *P. senaarensis* im Iran. Diese ist derzeit auf die südlichen Provinzen Sistan-Baluchestan, Kerman, Fars, Hormozgan und Bushehr beschränkt, wobei das weltweit nördlichste Vorkommen der Art in der Stadt Jiroft liegt.

References

- AGOSTI, D. 1990: Review and reclassification of *Cataglyphis* (Hymenoptera, Formicidae). – *Journal of Natural History* 24: 1457-1506.
- ANDERSEN, A.N. 1997: Functional groups and patterns of organization in North American ant communities: a comparison with Australia. – *Journal of Biogeography* 24: 433-460.
- AKBARZADEH, K., TIRGARI, S. & NATEGHPUR, M. 2004: First record of presence of stinging ants *Pachycondyla senaarensis* (Formicidae: Hymenoptera) in Sistan and Baluchestan province. – *Proceeding of 16th Iran Plant Protection Congress*, Tabriz.
- BUNDY, G., CONNOR, R.J. & HARRISON, C.J. 1989: Birds of the Eastern provinces of Saudi Arabia. – Victor Gollancz, London, 211 pp.
- COLLINGWOOD, C.A. 1985: Hymenoptera: Fam. Formicidae of Saudi Arabia. – *Fauna of Saudi Arabia* 7: 230-302.
- COLLINGWOOD, C.A. & AGOSTI, D. 1996: Formicidae (Insects: Hymenoptera) of Saudi Arabia (Part 2). – *Fauna of Saudi Arabia* 15: 300-385.
- COLLINGWOOD, C.A., TIGAR, B.J. & AGOSTI, D. 1997: Introduced ants in the United Arab Emirates. – *Journal of Arid Environments* 37: 505-512.
- DEJEAN, A. & LACHAUD, J.P. 1992: Growth-related changes in predation behavior in incipient colonies of the ponerine ant *Ectatomma tuberculatum* (OLIVER). – *Insectes Sociaux* 39: 129-143.
- DEJEAN, A. & LACHAUD, J.P. 1994: Ecology and behavior of the seed eating ponerine ant *Brachyponera senaarensis* (MAYR). – *Insectes Sociaux* 41: 191-210.
- DIAMOND, J. & CASE, T.J. 1986: Overview: introductions, extinctions, exterminations, and invasions. In: DIAMOND, J. & CASE, T.J. (Eds.): *Community Ecology*. – Harper & Row, New York, pp. 65-79.
- DIB, G., GUERIN, B., BANKS, W.A. & LEYNADIER, F. 1995: Systemic reactions to the Samsun ant: an IgE-mediated hypersensitivity. – *Journal of Allergy and Clinical Immunology* 96: 465-472.
- HÖLLDOBLER, B. & WILSON, E.O. 1990: *The ants*. – The Belknap Press of Harvard University Press, Cambridge, MA, 746 pp.
- HOLWAY, D.A., LACH, L., SUAREZ, A.V., TSUTSUI, N.D. & CASE, T.J. 2002: The causes and consequences of ant invasions. – *Annual Review of Ecology and Systematics* 33: 181-233.
- LACHAUD, J.P. & DEJEAN, A. 1994: Predatory behavior of seed-eating ant: *Brachyponera senaarensis*. – *Entomologia Experimentalis et Applicata* 72: 145-155.
- LEVIEUX, J. & DIOMANDE, T. 1978: La nutrition des fourmis granivores. II. Cycle d'activité et régime alimentaire de *Brachyponera senaarensis* (MAYR) (Hymenoptera, Formicidae). – *Insectes Sociaux* 25: 187-196.
- MANDAVILLE, J.P. 1986: Plant life in the Rub' al-Khali (the Empty Quarter), south-central Arabia. – *Proceedings of the Royal Society of Edinburgh* 89B: 147-157.
- MCGLYNN, T.P. 1999: The worldwide transfer of ants: geographical distribution and ecological invasions. – *Journal of Biogeography* 26: 535-48.
- PAKNIA, O. 2002: Study of fauna and geographical distribution of stinging ants (Hymenoptera: Formicidae) and their medical importance in Lar city (Lar county). – Unpublished Master thesis, Tarbiat Modares University, Tehran, 188 pp.
- PARKER, I.M., SIMBERLOFF, D., LONSDALE, W.M., GOODELL, K. & WONHAM, M. 1999: Impact toward a framework for understanding the ecological effects of invaders. – *Biological Invasions* 1: 3-19.
- PASSERA, L. 1994: Characteristics of tramp ants. In: WILLIAMS, D. (Ed.): *Exotic ants*. – Westview Press, Boulder, pp. 23-43.
- PIMM, S.L. 1991: *The balance of nature: Ecological issues in the conservation of species and communities*. – University of Chicago Press, Chicago, 448 pp.
- SUAREZ, A.V., HOLWAY, D.A. & CASE, T.J. 2001: Patterns of spread in biological invasions dominated by long-distance jump dispersal: Insights from Argentine ants. – *Proceedings of the National Academy of Sciences of the United States of America* 98: 1095-1100.
- TABER, S.W. 2000: *Fire ants*. – Texas A&M University Press, Texas, 308 pp.
- TAYLOR, B. 2005: The ants of Africa. – http://antbase.org/ants/africa/distribution_cards/pachycondyla_senaarensis.htm, retrieved on 14 February 2006.
- TIRGARI, S. & PAKNIA, O. 2005: First record of Ponerine ant (*Pachycondyla senaarensis*) in Iran and some notes on its ecology. – *Zoology in the Middle East* 34: 67-70.
- TIRGARI, S., PAKNIA, O., AKBARZADEH, K. & NATEGHPUR, M. 2004: First report on the presence and medical importance of stinging ant in Southern Iran (Hym: Formicidae: Ponerinae). – XXII International Congress of Entomology. Brisbane, Queensland, Australia.
- WILLIAMS, D.F. 1994: *Exotic Ants: Biology, Impact, and Control of Introduced Species*. – Westview Press, Boulder, 332 pp.