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NATIVE BEES (HYMENOPTERA: APOIDEA: APIFORMIS) OF SRI LANKA AND THEIR IMPORTANCE IN AGRICULTURE AND BIODIVERSITY

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ABSTRACT

A taxonomic review of the bees (Apoidea: Apiformis) of Sri Lanka was carried out along with an observational study on bee pollinators of cucumber. Five families, Anthophoridae, Apidae, Colletidae, Halictidae and Megachilidae are represented by 49, 4, 3, 52, and 24 species respectively. A list of 132 bee species known to occur in Sri Lanka is given with short general descriptions of the families and family groups they belong to. From an observational study it was found out that there was no fruit set in cucumber variety LY 58 when insects were prevented from visiting flowers. Ten species of bees visited cucumber flowers of which *Apis cerana*, *Ceratina* sp., and *Pithitis* sp. were the most frequent. The possible impact of native bees on agriculture production and biodiversity is discussed. Lack of or inadequate pollination of crops may reduce the crop yields and quality of produce. The decline of native bees due to human activity may adversely effect biodiversity.

KEY WORDS: Agriculture, Apoidea, Biodiversity, Hymenoptera, Pollination, Sri Lanka.

INTRODUCTION

Bees are a group of about 20,000 species of insects in the order Hymenoptera distributed throughout the world (Michener, 1993). They are closely related to wasps but differ from them by being phytophagous in both larval and adult stages. Some have evolved to be highly social (eusocial) like the honey bees but many others are solitary (Roubik, 1989). Except for the honey bee, *Apis cerana*, other bees of Sri Lanka have not been well studied either systematically or biologically. Much of the information derived from considerable amounts of research on honey bees of Sri Lanka can be found in Punchihewa (1994), but no comparable treatments exist for other bees. The Catalogue of Hymenoptera (Dalla Torre, 1896) listed 17 bee species from Sri Lanka and Bingham (1897) reproduced the descriptions of 47 species. Since then more species of bees from Sri Lanka have been recorded and described by many authors but, this information is scattered in the vast taxonomic literature. Although bees are a very important group that is required to be studied in relation to agriculture and biodiversity no attempt has been made in Sri Lanka to study them up to now. The importance of bees for agriculture and biodiversity rests on the fact that they have evolved to be specialized pollinators of many plant species. Their habit of mass or progressive provisioning of larvae with pollen and nectar as food has led to the evolution of close interdependence between bees and flowering plants (angiosperms).

Although most of the world's food supply comes from wind pollinated or self pollinated crops, the value of insect pollinated crops is substantial

(McGregor, 1976). Many fruit and vegetable crops are dependent on insects for pollination or benefit by flower visiting insects of which bees are the most prominent group. Pollination not only affects the crop yield but also affects the quality of the produce. The lack of pollination would reduce the fruit set and inadequate pollination would lead to a higher percentage of inferior fruits and sterile seeds (Kearns and Inouye, 1997). Therefore presence of bees and other pollinators in adequate numbers is necessary for optimal agricultural production.

Not so obvious as the relevance to crop production is the bees' role in maintaining biodiversity. Recent attention on decreasing biodiversity in many areas of the world has induced the study of the role of bees on maintaining biodiversity (Neff and Simpson, 1993; O'Toole, 1993). Both in agriculture production and maintaining biodiversity, it is not only the presence of bees that is important but also presence in sufficient numbers.

The study was initiated in 1998 on pollination of cucurbitaceous crops in Sri Lanka. This study has compiled a list of bees known to occur in Sri Lanka and has made some observations on cucumber pollination and bees visiting cucumber flowers.

MATERIALS AND METHODS

Taxonomic literature was surveyed (upto December 1999) for bees described or recorded from Sri Lanka. The bee species known to occur in the country were noted and the taxonomic history for each species was reviewed to determine the currently valid scientific names.

Bees visiting cucumber flowers were collected in an observational study carried out during the seasons 1998 *yala* (May-September), 1998/99 *maha* (November-March) and 1999 *yala* at the research fields of Horticultural Crops Research and Development Institute, Gannoruwa. Commonly cultivated cucumber variety LY 58 was planted according to the Department of Agriculture recommendations, in 12, 4X3 m plots. To study the effect of insect pollinators the same variety was planted in a net house at the In Service Training Institute, Gannoruwa, which effectively excludes all flower visiting insects. Although the cucumber vines in the field were not provided with trellises, the net house crop was allowed on triangular trellises 1.5 m high, for easier management. From the net house cultivated plants, few randomly selected female flowers were hand pollinated to ascertain that the abiotic net house environment does not affect fruit set of the cucumber variety.

RESULTS AND DISCUSSION

Bees are grouped in the superfamily Apoidea which also includes sphecoid wasps. Michener (1993) divided bees into eleven families. Five of the families, Anthophoridae, Apidae, Colletidae, Halictidae and Megachilidae, are represented in Sri Lanka. While Apidae includes all the eusocial bees, the other families consist mostly of solitary and parasocial bees. Little is known about the biology of most of the native bees of Sri Lanka. Some relevant biological information and a key useful for identification of genera can be found in Batra (1977).

List of bees in Sri Lanka

In the following section bees known to occur in Sri Lanka are listed under their respective families. A short general introduction to each family, based mainly on O'Toole and Raw (1991) is followed by the currently valid species names in bold letters and a recent reference to the valid name. Collection localities, when found in literature, and any junior synonyms relevant to Sri Lanka are indicated under each specific name.

Anthophoridae

Anthophoridae is a large family with thousands of species distributed world wide. Many are large bee as common carpenter bees in Sri Lanka. Anthophoridae is divided into three subfamilies, Anthophorinae, Nomadinae and Xylocopinae.

Anthophorinae

In Anthophorinae most species nest in the ground and few excavate dead wood. It is represented in Sri Lanka by *Amegilla* (Tribe: Anthophorini), *Tetralonia, Thygatina* (Eucerini), *and Thyreus* (Melectini).

Anthophorini

Amegilla (Zonamegilla) cingulata (Fabricius): Brooks 1988: 511
Amegilla (Zonamegilla) cingulifera (Cockerel)*: Brooks 1988:511;
Colombo, Kalutara, Ratnapura.
Amegilla (Zonamegilla) comberi (Cockerel)*: Brooks 1988: 511;
Galie, Hambantota, Mannar, Matara, Monaragale, Puttalama, Ratnapura.
* From specimens in Smithsonian collection identified by M.A. Lieftnick (1987)
Amegilla (Zebramegilla) fallax (Smith): Brooks 1988: 504;
Mahailluppalama (MI), Haputale, Seenigoda.
Amegilla (Glossamegilla) insularis (Smith): Brooks 1988: 513

Amegilla (Amegilla) quadrifasciata (de Villers): Brooks 1988: 450
Amegilla (Zonamegilla) puttalama (Strand): Brooks 1988: 511; Bandarawela, Negambo.
Amegilla (Zonamegilla) subinsularis (Strand)*: Brooks 1988: 513; Galle, Kalutara, Rantnapura.
* From specimens in Smithsonian collection identified by M.A. Lieftnick (1987).
Amegilla (Zebramegilla) subcoerulea (Lepeletier): Brooks 1988: 504; Kalutara
Amegilla (Glossamegilla) violacea (Lepeletier): Brooks 1988: 513; MI, Seenigoda.
Amegilla (Zonamegilla) zonata (Linnaeus): Brooks 1988: 511; Bandarawela, Haputale, MI, Negambo, Puttalama, Seenigoda.
Tetralonia commixtana Strand 1913: 146; Nuwara-Eliya,
Tetralonia taprobanicola Strand 1913: 147; Kantale
Thygatina fumida Cockerell 1911b: 237; Kandy

All species in Melectini do not make nests and lay their eggs in nests of other anthophorine bees (such bees are called Cuckoo Bees)

Thyreus ceylonicus ceylonicus (Friese): Lieftinck 1962: 134; Anuradhapura, Deiyannewela, Hantana, Haragama, Kandy, Kantale, Kuchchaveli, Mihintale, Nalanda, Nugawela, Peradeniya, Puttalama, Teldeniya, Trincomalee, Weligama.
Thyreus histrio (Fabricius): Lieftinck 1962: 11; Awissawella, Dambulla, Kandy, Negambo, Tissa, Peradeniya, Trincomalee.
=*Crocisa rectangula* Meyer: Lieftinck 1959: 25, 34
Thyreus insignis (Meyer): Lieftinck 1962: 109; Kandy, Walawela.
Thyreus ramosellus (Cockerell)*: Lieftinck 1962: 17; Puttalama, Trincomalee.
* From specimens in Smithsonian collection identified by M.A. Lieftnick 1987.
Thyreus takaonis (Cockerell): Lieftinck 1962: 21; Awissawella, Balakaduwa, Dambulla, Kalpitiya, Mannar, Matale, Mihintale, Nalanda, Negambo, Paradna, Puttalama, Seenigoda, Tissa, Uragalla, Weligama.
=*Crocisa ramosa* var *reepeni* Friese 1918: 496
Thyreus surniculus Lieftinck: Lieftinck 1962: 27; Inginiyagala, Mannar, Passara, Tambuttegama, Tissamaharama.

Nomadinae

Nomadinae is represented by *Nomada* in the tribe Nomadini. All species of Nomadinae are Cuckoo bees.

Nomada adusta Smith: Alexander & Schwarz 1994: 256
Nomada antennata Meade-Waldo: Alexander & Schwarz 1994: 256; Kandy.

Nomada bicellula Schwarz: Alexander & Schwarz 1994: 256
Nomada ceylonica Cameron: Alexander & Schwarz 1994: 256
Nomada lusca Smith: Alexander & Schwarz 1994: 257
Nomada priscilla Nurse: Alexander & Schwarz 1994: 257
Nomada wickwari Meade-Waldo: Alexander & Schwarz 1994: 257; Colombo

Xylocopinae

Xylocopinae are known as carpenter bees due to their habit of excavating nests in solid wood or pith of plant stems. This subfamily is represented by *Braunsapis* (Allodapini), *Ceratina*, *Pithitus* (Ceratinini) and *Xylacopa* (Xylacopini).

Tribe Allodapini include subsocial or primitively eusocial bees that nest in pithy stems or twigs. Four species are known from Sri Lanka.

Braunsapis cupulifera (Vachal): Reyes 1991: 197
Braunsapis flaviventris Reyes 1991: 194
Braunsapis mixta (Smith): Reyes 1991: 187; Colombo, Gampaha, Hiniduma, Medirigiriya, Nalanda, Puttalama, Yakkala.
=*Prosopis leucotarsis* Cameron 1897: 363
=*Allodape marginata*:Smith: Strand 1913: 145
Braunsapis picitarsis (Cameron): Reyes 1991: 189; Kollupitiya, Medirigiriya, Sigiriya, Yakkala.

The smaller carpenter bees are in the tribe Ceratinini. They usually nests in pithy stems and are common. While *Ceratina* can either be solitary or primitively social all known *Pithitis* species are solitary.

Ceratina (Xanthoceratina) beata Camaron: Vecht 1952: 48; Trincomalee
Ceratina (Ceratinidia) hieroglyphica Smith: Michener 1965: 221; Dambulla, Nalanda, Weligama.
Ceratina (Xanthoceratina) picta Smith: Hirashima 1971: 356
Pithitis (Pithitis) binghami (Cockerell): Hirashima 1969: 658
Pithitis (Pithitis) smaragdula (Fabricius): Hirashima 1969: 661; Bentota, Kantale, Sigiriya.

Large carpenter bees are grouped in the tribe Xylocopini. They are probably the most familiar group of bees other than honey bees. Most of them are solitary and excavate their nests in hard wood. *Xylacopa tranquebarica* is known to be nocturnal (Batra, 1977).

Xylocopa (Biluna) auripennis Lepeletier: Hurd & Moure 1963: 297; Habarana
Xylocopa (Biluna) nasalis Westwood: Hurd & Moure 1963: 310

=*Xylocopa dissimilis* Lepeletier: Bingham 1897: 538
Xylocopa (Ctenoxylocopa) fenestrata (Fabricius): Tkalcu 1973: 63; Aluthnuwara, Balangoda, Hambantota, Nalanda, Paradna, Seenigoda, Talawa.
Xylocopa (Koptortosoma) aestuans (Linnaus): Hurd & Moure 1963: 296
Xylocopa (Koptortosoma) bryorum Fabricius: Hurd & Moure 1963: 299
Xylocopa (Koptortosoma) confusa Perez: Hurd & Moure 1963: 301; Anuradhapura, Nalanda.
Xylocopa (Koptortosoma) ruficornis Fabricius: Hurd & Moure 1963: 314; Bandarawela , MI, Tharakundu (NW Mannar)
=*Xylocopa ceylonica* Cameron 1901: 32
=*Xylocopa clavicrus* Maidl: Strand 1913: 146
=*Xylocopa verticalis* Lepeletier: Friese 1918: 495
=*Mesotrichia* (*Koptortosoma*) *ruficornis* Fabricius: Tkalcu 1973: 63
Xylocopa (Nodula) amethystina (Fabricius): Hurd & Moure 1963: 297; MI, Matale
Xylocopa (Platynopoda) tenuiscapa Westwood: Hurd & Moure 1963: 317; Balangoda, Colpetty, Galle, Hambantota, Hikkaduwa, Inginiyagala, Kuchchaveli, Labugama, Ratmalana, Trincomalee, Wellawaya.
=*Xylocopa albofasciata* Sichel: Bingham 1897: 542
=*Mesotrichia* (*Platynopoda*) *tenuiscapa* Westwood: Tkalcu 1973: 63
Xylocopa(Nyctomelitta) tranquibarica (Fabricius): Hurd & Moure 1963: 317; Kantale
Xylocopa (Zonohirsuta) bhowara Maa: Hurd & Moure 1963: 298
Xylocopa (Zonohirsuta) dejeanii Lepeletier: Hurd & Moure 1963: 302; Anuradhapura, Colombo.
=*Xylocopa collaris* Lepeletier: Bingham 1897: 543
Xylocopa (Zonohirsuta) nigrocaerula Smith: Hurd & Moure 1963: 311

Apidae

Apidae include all the eusocial bees and it is divided into four subfamilies. Except Bombinae, which consist of bumble bees and euglossinae, the orchid bees, the other two subfamilies are represented in the country.

Apinae

There are three species of honey bees in Sri Lanka.

Apis dorsata Fabricius: Michener 1990: 141; Nalanda
Apis florea Fabricius: Michener 1990: 141; Kandy, Matale, Nalanda, Negambo, Pankulam, Paradna, Puttalama, Weligama
Apis cerana Fabricius: Ruttner 1988:120; Haputale, Seenigoda.
=*Apis indica* Fabricius: Bingham 1897: 558

Meliponinae

Meliponinae consist of stingless bees, which are distributed in the tropics world over. Sri Lanka has a single species which nests in places like hollow logs, tree trunks etc.

Trigona (Heterotrigona) iridipennis Smith: Sakagami 1978: 216; Colombo, Elephant-Pass, Hambantota, Kottawa, Lahugala, Labugama, Nalanda, Palatupana, Sigiriya, Sinharaja, Ukgaltota, Wellawaya, Trincomalee.
=*Trigona praeterita* Walker1860: 305

Colletidae

Colletidae consists of over 2000 species in the world and divided into five subfamilies (Michener, 1993). The Sri Lankan species belongs to Hylaeinae, members of which are distributed worldwide. The females of colletids line their brood cells with a transparent water proof membrane resistant to fungal attack. Hylaeine bees are relatively hairless and lack pollen scopa. Females transport pollen in their crops. Many species nest in plant stems, plant galls, beetle borings, old cells of bees and wasps and some nest in the ground.

Hylaeus (Paraprosopis) krombeini Snelling 1980: 3; Hunuvilgama (Wilpattu)
Hyleaus (Prosopis) monilicornis (Motschulski): Snelling 1980: 1
Hylaeus sedens Snelling 1980: 13; Kandy

Halictidae

This family of bees has over 5000 species described worldwide. Many halictids are metallic in coloration and includes solitary as well as primitively eusocial bees. All three subfamilies, Rophitinae, Halictinae and Nomiinae are represented in Sri Lanka. Most halictids escavate nests in the ground and line their brood cells with a mixture of chemicals, which is not transparent as in colletids.

Rophitinae

Rophitinae is represented by *Systropha*.

Systropha tropicalis Cockerell: Baker 1996: 1535; Kandy, Matale, Seenigoda.
=*Systropha butteli* Friese, 1913: 87

Halictinae

Halictinae are called sweat bees due to their attraction to human perspiration. Thay are represented by *Halictus*, *Homalictus*, *Lasioglossum*, *Pachyhalictus* (Halictini) and *Ceylatictus* (Nomiodini).

Halictus ciris Cameron: Bluthgen 1926: 537; Kandy, Matale, Nigambo.
Halictus ducalis Bingham: Bingham 1897: 435
Halictus paradnanus Strand: Bluthgen 1926: 456; Colombo, Paradna (probably Peradeniya).
Halictus taprabonae Cameron: Bingham 1897: 428
Halictus timidus Smith: Bingham 1897: 429
Halictus trincomalicus Cameron: Bluthgen 1926: 608; Trincomalee
Halictus (Seladonia) lucidipennis Smith: Sakagami & Ebmer 1987: 321; Angunakolapelessa, Colombo, Ella, Hasalaka, Hunuvilgama, Kandy, Kokmotte, Labugama, Lahugala, , Padaviya, Palatupana, Parayanakulam, Pimburathewa, Ratmalana , Teldeniya, Trincomalee, Udawalawa.
=*Halictus vernalis* Smith: Ebmer 1980: 181
Homalictus singhalensis (Bluthgen): Michener 1965: 181
Lasioglossum (Ctenonomia) clarum (Nurse): Sakagami 1990*: Anuradhapura, Hambantota, Mannar, Monaragala, Pollonnaruwa, Trincomalee.
Lasioglossum (Ctenonomia) vagans (Smith): Sakagami 1990*: Badulla, Colombo, Galle, Kandy, Matale.
=*Halictus schmiedeknechti*: Friese 1918: 493
=*Halictus nalandicus* Strand 1913: 140
=*Halictus centrophorus* Strand 1913: 140

*From specimens in Smithsonian collection identified by Sakagami (1990).
Lasioglossum (Lasioglossum) albescens Smith: Michener 1965: 173; MI, Nalanda, Trincomalee.
=*Hlictus javanicus*: Friese 1918: 493
=*Halictus amblypygus*Strand 1913: 141
Lasioglossum (Lasioglossum) semisculptum (Cockerel): Michener 1965: 173; Kalutara.
Lasioglossum (Lasioglossum) tamulicum (Bluthgen): Michener 1965: 173
Lasioglossum (Nesohalictus) halictoides (Smith): Sakagami 1991: 169; Anuradhapura.
=*Halictus ceylonicus* Strand 1909: 187
=*Halictus strandiellus* Cockerell 1911a: 192
=*Halictus hornianus* Strand1913: 138
Lasioglossum (Nesohalictus) serenum (Cameron): Sakagami 1991: 169; Colombo, Angunakolapelessa.
Lasioglossum (Sudila) alphenum (Cameron): Sakagami, Ebmer and Tadauchi 1996: 164; Haputale, Kandy, Nuwara-Eliya.

=*Halticus ceylonicus* Cameron 1902: 254
=*Ceylonicola submicans* Friese 1918: 504

Lasioglossum (Sudila) aulacophorum (Strand): Sakagami, Ebmer and Tadauchi 1996: 154: Hatton.

Lasioglossum (Sudila) bidentatum (Cameron); Sakagami, Ebmer and Tadauchi 1996: 175: Hakgala, Kande-Ela Reservoir, Nuwara-Eliya, Ohiya, Pidurutalagala, Worlds End.

=*Sudila ceylonica* Cameron 1898: 55
=*Ceylonicola atra* Friese 1918: 502
=*Ceylonicola rebrivenrris* Friese 1918: 503

Lasioglossum (Sudila) kandiense (Cockerell): Sakagami, Ebmer and Tadauchi 1996: 160; Kandy, Kanneliya, Kitulgala, Sinharaja.

Pachyhalictus (Pachyhalictus) bedanus (Bluthgen): Michener 1978: 517; Peradeniya.

Pachyhalictus (Pachyhalictus) kalutarae (Cockrel): Michener 1978: 518; Kalutara, Peradeniya, Pundalu-Oya.

=*Halictus amplicollis* Friese 1918: 500

Pachyhalictus (Pachyhalictus) sigiriellus (Cockerell): Michener 1978: 518: Kalutara.

Pachyhalictus (Pachyhalictus) vinctus (Walker): Michener 1978: 518

Nomiodini

Nomiodini are minute bees with abundant yellow to white markings on the body.

Ceylalictus cereus (Nurse): Pesenko 1983: 108: Colombo.
=*Ceratina divisa* Cameron 1907: 1003

Ceylalictus horni (Strand): Pesenko 1983: 108: Matale.

Ceylalictus taprobanae (Camaron): Pesenko 1983: 108

Nomiinae

Nomiinae are mostly solitary bees. They are represented in Sri Lanka by *Nomia* and *Steganomus*.

Nomia biroi Friese: Seenigoda: Friese 1918: 507; Polgahawela, Ragama.

Nomia butteli Friese: Friese 1918: 505: Seenigoda.

Nomia capitata Smith: Bingham 1897: 455

Nomia carinata Smith: Bingham 1897: 453

Nomia ceylonica Friese: Friese 1918: 506: Seenigoda.

Nomia crassiuscula Friese: Friese 1918: 504: MI.

Nomia elegantula Friese: Friese: 1918: 505; Seenigoda.

Nomia exagens (Walker) Cockerell 1911b: 218

Nomia matalea Strand 1913: 144; Matale, Negambo, Paradna.
Nomia oxybeloides Smith: Strand 1913: 145: Negambo, Sigiriya.
Nomia puttalama Strand 1913: 143; Horrowpatana, Puttalama.
Nomia rufa Friese: 1918: 508: Peradeniya.
Nomia rustica Westwood: Bingham 1897: 457
Nomia (Austronomia) austella Hirashima 1978: 92; Palatupana (Hambantota)
Nomia (Austronomia) krombeini Hirashima 1978: 98: Colombo, Hambantota, Hunuwilgama, (and various other locations).
Nomia (Austronomia) notiomorpha Hirashima 1978: 100; Ekgal-Aru, Hambantota, Hasalaka, Kandy, Mahiyangana, Parayanakulam, (and various other locations)
Nomia (Austronomia) ustula Cockerell: Hirashima 1978: 96; Anuradhapura, Dambulla, Labugama, Gilimale, Kandy, Manampitiy, Padaviya, Pimburattawa, Puttalama, Ratnapura, Wilpattu
Nomia (Hoplonomia) strigata (Fabricius): Michner 1965: 156; Puttalama.
Nomia (Hoplonomia) westwoodi Gribodo: Michener 1965: 156; Negambo.
Normia (Nomia) curvipes (Fabricius): Michener 1965: 154
Nomia (Rhopalomelissa) aurifrons Smith: Michener 1965: 159; Negambo.
Nomia (Rhopalomelissa) basipicta Wickwar: Michener 1965: 159:
Nomia (Rhopalomelissa) carinicollis Cameron: Michener 1965: 159
Nomia (Rhopalomelissa) comberi Cockerell: Michener 1965: 159; Kalutara.

Steganomus nodicornis Smith: Strand 1913: 142: Negambo, Matale

Megachilidae

A large family of bees with thousands of species distributed worldwide. Of the two subfamilies only Megachilinae is found in Sri Lanka. Three tribes are represented.

Megachilinae

Megachilinae are commonly called leaf-cutter and mason bees. Majority of the species make nests in existing cavities in wood. Most line their cell walls or partition the cells with material collected by the females. The kinds of material varies according to the species and include leaves, petals, chewed leaves or petals, plant or animal hairs, plant resins or mud and pebbles. Megachilinae is represented by *Lithurgus* (Lithurgini), *Anthidiellum*, *Euaspis, Exanthidium,* (Anthidini) and *Coelioxys*, *Liothyrapis*, *Megachile* (Megachilini).

Lithurgini are solitary bees, known to excavate their nests in timber and they do not line their cells.

Lithurgus (Lithurgus) atratus Smith: Michener 1965: 185

Anthidiini

Anthidiellum (Pycnanthidium) ramakrishnae (Cockerell): Pasteels 1972: 98; Passara

Euaspis (Parevaspis) edentata Baker: Baker 1995: 283; Kandy, Matale, Minneriya, Pollebedda.
=*Euaspis* (*Parevaspis*) *carbonaria* (Smith): Pasteels 1980: 82,

Exanthidium rotundiventre Pasteels 1987: 234

Liothyrapis apicata Smith: Pasteels 1987: 233; Padaviya

Megachilini

Coeloxys confusus Smith: Pasteels 1987: 225; Palatupana, Trincomalee.
Coelioxys fenestrata Smith*; Kandy, Trincomalee.
Coelioxys fuscipennis Smith*; Hambantota.
Coelioxys intacta Friese*; Ampara.
* From specimens at Smithsonian collection identified by J. Pasteels (1997).
Coeloxys nitidoscutellaris Pasteels 1987: 228; Palatupana
Coeloxys (Allocoelioxys) angulata Smith: Pasteels 1987: 229; Wilpattu, Trincomalee.
Coeloxys (Allocoelioxys) capitata Smith: Pasteels 1987: 230; Angunakolapellessa, Kandy, Mavillu (Mannar), Palatupana, Pessalei, Sigiriya, Trincomalee.
Coelioxys (Allocoelioxys) taiwanensis Cockerell: Pasteels 1987: 232; Angunakolapellessa, Wilpattu.
Megachile ardens Smith: Bingham 1897: 475
Megachile ceylonica Bingham: Bingham 1897: 482
Megachile conjuncta Smith: Bingham 1897: 482
Megachile disjuncta Fabricius: Strand 1913: 149; Nigambo, Puttalama.
Megachile kandyca Friese 1918: 512; Kandy.
Megachile lanata (Fabricius): Bingham 1897: 483
Megachile reepeni Friese 1918: 512; MI.
Megachile relata Smith: Strand 1913: 149; Nalanda.
Megachile umbripennis Smith: Strand 1913:149; Matale.
Megachile vigilans Smith: Bingham 1897: 488
Megachile (Callochile) mystaceae (Fabricius): Michener 1965: 210; MI.

Cucumber pollination and bees

In the field cucumber flowers were visited by *Apis cerana*, *A.dorsata*, *A florea*, *Ceratina* sp., *Megachile* sp., *Nomia* sp., *Pithitis* sp., *Xylocopa fenestrata*, *X. tenuiscapa* and *Trigona iridipennis*. The most frequent flower visiting bees were *Apis cerana*, *Ceratina* sp. and *Pithitis* sp. Deformation of the cucumber fruits (fruits with uneven growth) was very common in the field. It was hypothesized that inadequate pollination may cause deformation of cucumber fruits. However, it was found that oviposition by the melon fly *Bactocera cucurbitae* on very young fruits also induced fruit deformation. To avoid melon fly attack the female flowers were covered with paper bags the day after they bloomed. The developed fruits did not have any melon fly damage but covering did not yield only undeformed fruits contributing evidence for the hypothesis of fruit deformation due to inadequate pollination.

The observational study in the net house indicated that with exclusion of pollinators there was no fruit set in the cucumber variety used. Normal growth of fruits from all hand pollinated flowers confirmed that lack of fruit set is due to exclusion of pollinators.

The low yield of many fruit vegetables in Sri Lanka has been a concern for agriculturists who have tried to improve varieties and cultural practices to increase the yield. For example, the average yields of bitter gourd, cucumber and luffa in Sri Lanka are 5.8, 7.9, 6.7 mt /ha respectively, which is much lower than the potential yield of these crops estimated to be 20 - 20.5 mt /ha (Anonymous, 1998). Many female flowers failing fruit set and large number of deformed fruits in the cucumber plots suggest that at least some percentage of the gap between average and potential yield of cucumber is due to lack of adequate pollination. Although much attention has been paid to control of insect pest damages in Sri Lanka no attention so far has been paid to initial fruit set on which the final yield depends. It was observed that a large number of female flowers decayed without fruit set in all three crops mentioned above.

Bees and Agriculture

Honey bees have been effectively used as pollinators but the value of other bees has been less appreciated (O'Toole, 1993). There are numerous crops that depend upon or benefit from insect pollination. Some of these crops grown in Sri Lanka includes, avocado, bean, pepper, cocoa, carambola, cardamom, cashew, cherimoya, citrus, clove, coconut, coffee, cowpea, cucubits, brinjal, grape, guava, mango, mungbean, nutmeg, okra, onion, papaya, passion fruit, peanut, bell pepper, pigeon pea, pomegranate, sesame, soybean, strawberries, sunflower and tomato (McGregor, 1976). The mechanism of how these crops benefit from pollinators is not in the purview of this paper,

but the list indicates the wide range of crops that could be affected by lack of, or inadequate, pollination.

There has been a general decline of bee populations around the world threatening the agriculture production and stable food supply (Allen-Wardell, *et al.*, 1998). One of the major contributing factors for the low bee populations is use of insecticides (Johansen, 1977). Use of these chemicals, with no concern for their effect on pollinators, kill or repel many pollinators including bees. As much as we need to use insecticides in agriculture it is necessary to regulate their use to maximize the desirable effects while minimizing the undesirable effects. Different insecticides are poisonous to bees and other pollinating agents. In Sri Lanka consideration of these adverse effects have not be recognized when recommending insecticides. Most damage to pollinators occur during the time of spraying the crops but indirect effects of stomach poisoning by bees ingesting pollen with insecticides are also known. Hazards to bees can be reduced by application of insecticides in the evenings when bees do not forage. While in Sri Lanka we remain ignorant of our native bees their populations may have declined or gone extinct limiting crop yields.

Native bee populations in agricultural areas can be successfully manipulated to benefit crop production (Bohart, 1972). Efficiency of native bees as cop pollinators and possibility of manipulating them for agricultural production is yet to be studied in Sri Lanka. In the observational cucumber plots, nesting by a native species of *Megachile* was successfully induced using bamboo trap nests. Much research is needed on managing native bees in Sri Lanka. One of the very rewarding possibilities would be culturing of *Xylocopa* species for pollinating passion fruit. *Xylocopa* species are known to be efficient pollinators of passion fruits (Corbet and Willmar, 1980; Nishida, 1958) and it has been shown that they can be cultured in artificial nests (Abrol, 1993; Roubik, 1995). Another species with potential in Sri Lanka is *Trigona irridipennis*. Results of using *Trigona ninangkabu* for pollination of strawberries in net houses in Japan indicate the potential for using the local stingless bee for pollination of such crops (Katutani et al, 1993). *Trigona* species are known to play important role in pollination of may crops including Mango and Rambutan (Heard, 1999).

Agriculture can benefit by introduction of foreign bees. But such introductions should be carried out with utmost care after thorough studies on possible harmful effects. Bohart (1962) has discussed the value and problems of such introductions. Some adverse effects include the inadvertent introduction of arthropod diseases, parasites and predators; insects with undesirable characters such as stinging, biting people and destroying flowers and insects that molest or dispossess efficient native pollinators. When alien

species are introduced there is always the possibility of them establishing in the local environment. For example, in Japan a bumble bee introduced for crop pollination, *Bombus terrestris*, has recently been found in the wild (Kearns *et al,* 1998). In the process foreign bees may out compete to drive some local bees to extinction, leading to cascading negative effects on biodiversity.

Bees and biodiversity

Bees contribute directly to the diversity of organisms in different habitats by being a group of species-rich and biologically complex insects and they indirectly help maintain the floral diversity of these habitats by being efficient pollinators. It has been shown that the current levels of plant diversity could not be maintained in most communities if the diversity of bees was reduced (Neff and Simpson, 1993). At least 67% of the angiosperms in the world are known to depend on insects for pollination (Kearns and Inouye, 1997). Different plant species are best pollinated by different species. For example *Indigofera* spp. are best pollinated by the species of *Nomia* and *Pithitis* bees while *Callotropis* are best pollinated by the carpenter bees (*Xylocopa*) and *Garcinia* by stingless Bees (*Trigona*) (Batra, 1993). It is necessary to identify these specific requirements and take necessary precautions to conserve bees. The flora of Sri Lanka consists of 926 endemic angiosperm species (Wijesundara, personal communications). As an efficient group of pollinators bees can effect survival of these plant species. Their scarcity not only reduces seed set but effects the reproduction of plants resulting in less vigorous offspring by inducing more seed setting through self pollination and reducing pollen competition (Kearns and Inouye, 1997). Progenies of plants with higher percentage of inbred offsprings will be less adaptable to changing environmental conditions due to their low genetic variability (Allen-Wardel *et al*, 1998).

Habitat fragmentation due to human activities has become a major threat to species survival in the world (Aizen and Feinsinger, 1994; Jennersten, 1998, Lamont *et al*, 1993). Many organisms need to have a certain minimum area of its natural habitat for survival in the prevailing dynamic equilibrium state of the ecosystems. As in any other organism habitat fragmentation due to human activities, such as opening up of forests, construction of dams and inundation of flood plains, and use of pesticides are known to deplete bee diversity and their populations (Batra, 1993). Although no data available to show that it has happened in Sri Lanka we can safely assume that such development activities which have been commonplace in the country not only has led to reduction of the forest cover to 22% but also has adversely effected the native bees.

Although there are 132 bee species described from Sri Lanka (almost half of them before 20th century) there is no guarantee that all of them survive today. Even the surviving populations may be not of high enough density as indicated by very infrequent visits of most native bees to cucumber flowers in observational plots. In addition to not using native bees for our advantage we inadvertently may have contributed to their demise. Hopefully it is not too late to initiate research for understanding the role of bees in agriculture and biodiversity and thereby help feeding a healthy society.

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