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## Photographic catalogue of hymenopteran pollinators in agricultural landscape area of South Gujarat

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### Abstract

The study on preparation of photographic catalogue of hymenopteran pollinators in agricultural landscape area of South Gujarat was carried out through survey of the different districts of South Gujarat *i.e.* Bharuch, Narmada, Surat, Tapi, Navsari, The Dangs and Valsad during September 2017 to December 2019. The insect pollinators of hymenoptera order were observed, collected and identified upto species level. The photographic catalogue of 44 hymenopteran pollinators recorded in agricultural landscape area of South Gujarat was prepared and published for its further use of identification and conservation.

**Keywords:** Pollinators, Hymenoptera, photographic catalogue

### Introduction

Pollination, an essential ecosystem service provided by insect pollinators, is many times taken for granted and little attention is paid to the need of conserving and enhancing the pollinator diversity in crop ecosystem. Majority of insect pollinators belong to three orders *viz.* hymenoptera, lepidoptera and diptera<sup>[1]</sup>. Pollination by insects often occurs on plants that have developed coloured petals and a strong scent to attract various insect pollinators have been observed to engage in flower fidelity, which means they are more likely to transfer pollen to other conspecific plants<sup>[2, 3, 4, 5, 6]</sup>.

Among the insect, hymenopterans are highly evolved and constitute the most important group of pollinating insects. Even in hymenoptera bees belonging to the superfamily Apoidea containing an estimated 25000 described species including wasps, ants, chalcids, ichneumons, sawflies, etc. belonging to 250 genera and 11 families are regarded as the most important group of insect pollinators<sup>[7]</sup>. However, the most studies to date have focused on *Apis* pollinators largely ignoring non-*Apis* pollinators, many of which also plays important role in pollination services. The conservation and management of insect pollinators is gaining importance day by day for which studies on pollinators diversity, species richness and abundance are essential<sup>[8]</sup>.

Among the insect pollinators, hymenopteran pollinators are highly grownup and constitute the most important group of pollinating insects. We show that non *Apis* hymenopterans are also efficient visitors of crop flowers for pollination purpose. The information on hymenopteran pollinators of South Gujarat with its key characteristics is not available. Looking towards the presence of insect pollinators without identifications is meaningless to know its role and significance in crop pollination and its conservation practices. Therefore, the catalogue manual of hymenopteran pollinators is designed with systemic order to guide adequately to entomologists, agriculturists, researchers, students, extension workers, and progressive farmers of the region. It is often the most overlooked non *Apis* pollinators species that also play the considerable role in pollinating crop plants, which can be identified through the study of diversity of non *Apis* bees, wasps etc. urging pollination.

### Materials and Methods

#### Study area

The study was conducted in the different districts of South Gujarat *i.e.* Bharuch, Narmada, Surat, Tapi, Navsari, The Dangs and Valsad during September 2017 to December 2019. South Gujarat is situated in the south part of the Gujarat state in the coastal low land on the western part. The total geographic area of South Gujarat is 17,500 km<sup>2</sup>.

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South Gujarat with coordinates: 21° 1702' N to 21° 4766' N (North latitude) and 72° 8013'E to 72° 8854'E (East longitude). The average annual rainfall received by the tract is about 1633 mm. In general, the monsoon is observed to commence from the second fortnight of June and withdrawn by the third week of September and the rainfall is mainly due to the South-West monsoon. The winter season usually sets at the end of October and temperature starts declining in the first fortnight of November and the lowest in December or January. The summer commenced from middle of February and continue up to first fortnight of June and temperature reaches to the maximum in May, hence it is the hottest month of the season. It has a coastal line open to the Arabian Sea from West and is bounded by Middle Gujarat on the North and Maharashtra on Southern as well as Eastern parts. On the East, it is contiguous to The Dang district with the forest and hilly evergreen as well as deciduous forest, revarian forest, mountains, water reservoirs, dams, ponds, plains, wetlands, canal areas, having alkaline soils, saline soils, and black fertile soils, etc.

### Survey, collection, identification and photography

Survey and collection of hymenopteran pollinators were made in South Gujarat (Narmada, Bharuch, Surat, Tapi, Navsari, Valsad and The Dangs districts) through the random selection of agricultural landscaped area under roving survey method. The spot observations were followed by photography and collection from the different areas for their taxonomical studies based on morphological observations. After noting characteristics and observations the live pollinators were released in the environment from where they collected. The collected and preserved specimens of different hymenopteran pollinators were identified by sending samples to GKVK, Bengaluru.

Close up photographs of all recorded insect species were captured with the help of SONY ALPHA 58 DSLR digital camera. Live specimens in the field condition were photographed so that natural colouration and specific behavioural postures can be documented. Photograph of preserved pinned insects was documented in the case of live specimens' photograph couldn't be captured. Photographic document of all the species with its comprehensive identification key was prepared. For the elimination of the lacuna in the identification of pollinators present in South Gujarat, the photographic catalogue was prepared as a tool for the identification of existing hymenopteran pollinators of the region.

### Verification of pollinators

Insect foraging on crop flowers was collected and examined

for physical pollen loads (i.e. presence of pollen) on its body parts (i.e. legs, antennae, mouth parts, wings, abdominal tip, etc.) for its confirmation as a pollinator. For pollen observations, collected insects were observed under 10X magnifying glass for the presence of the pollen on its body, then insects were released in the same field from where they collected. Atleast 10 insects of all species were observed for presence of pollen on body and  $\geq 30$  per cent insects of the same species were found adequate pollen load on the body then that was considered as a pollinator. The habits, habitat and floral choice of pollinators were oversight in the study.

### Results and Discussion

The intensive study on the diversity of hymenopteran pollinators in agricultural landscape area of South Gujarat was carried out during September 2017 to December 2019. During the course of present study, total 44 species of hymenopteran pollinators were collected from seven districts of South Gujarat. The photograph taken of each species is depicted in photo 1 to 44 with natural condition and pinned photograph. Detailed description of each pollinator species of different families and photographs of pollinators are as under:

#### 1. *Amegilla cingulata* (Fabricius, 1775) (Plate 1)

*Andrena cingulata*, Fabr. *Sist. Ent.* p. 378, (Ref.: Bingham, 1897)<sup>[9]</sup>

*Podalirius cingulatus*, Dall. *Torr: Cat. x*, p. 263.

♀♂. Head and thorax densely, clypeus, face below the antennae and the bases of the abdominal segments thinly pubescent, the head and thorax finely punctured underneath the pubescence bases of the abdominal segments finely aciculate. Black; the labrum (except a lateral spot at base and the apical margin very narrowly), a spot at base of the mandibles, a sub apical line on the clypeus, a medial line broadening from above downwards at right angles to the subapical line, and a small triangular spot above the base on each side of the clypeus, pale yellowish white; the head and thorax with bluish-grey pubescence having an admixture of black hairs; a tuft of white pubescence on each side of the median segment; the legs covered with bluish-white pubescence above, black beneath, the posterior tibiae with long snow-white pubescence above and an abbreviated line of black pubescence above near its base; abdomen clothed with thin black pubescence, the apical margins of segments 1-4 (♀), 1-5 (♂) with broad transverse bands of bright metallic blue scale-like hairs; antenna) black; wings light fuscous-hyaline, nervures and tegulae dark brown.

♀♂. Length 14-15; expanse. 25-26 mm.

**Habitat:** All districts of South Gujarat



Plate 1: *Amegilla cingulata* (Fabricius, 1775)

**2. *Amegilla confusa* (Smith, 1854) (Plate 2)**

Smith, *Cat.* ii, p. 337, ♀. *Podalirius confusus*, *Dall. Torr. Cat.* x, p. 264. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head, thorax, and abdomen closely and finely punctured; head above and thorax densely pubescent. Black; the base of the mandibles, and the labrum, except a spot at each basal lateral angle, pale yellowish; clypeus black, a spot on each side, a transverse triangular spot above, and a medial comparatively broad line pale yellowish white, the margin also narrowly white in some specimens; pubescence on the vertex of the head and on the thorax above cinereous, sometimes fulvous, mixed with black hairs, on the cheeks and beneath and on the posterior femora behind white; legs with black pubescence, on the posterior tibiae above snow white, with an abbreviated black stripe at base; abdomen covered with a thin black pubescence, the apical margins of the basal four segments with fasciae of white pubescence; wings fusco-hyaline.

♂. Similar, smaller; the clypeus with broader yellow markings; the 5<sup>th</sup> abdominal segment with a transverse pubescent fascia on its apical margin.

♀. Length 13-15; expanse. 23-26 mm. ♂. Length 11-12; expanse. 21-23 mm.

**Habitat:** All districts of South Gujarat except Bharuch, Surat and Valsad



**Plate 2:** *Amegilla confusa* (Smith, 1854)

**3. *Apis cerana indica* (Fabricius, 1793) (Plate 3)**

*Fabr. Ent. Syst. Suppl.* p. 274; *Smith, Cat.* ii, p. 416; *Dall. Torr. Cat.* x, p. 598. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀♂. Head, thorax, and abdomen smooth and shining, sparsely pubescent, sometimes densely so. Head, thorax, and apical abdominal terminal segment black; the scutellum and basal five segments of the abdomen testaceous yellow; legs rufo-fuscous, pubescence cinereous; wings hyaline and iridescent.

♀ Similar; larger and darker. ♂ Similar, stouter built; darker, the thorax densely pubescent.

♀ Length 16; expanse. 32 mm. ♂ Length 13; expanse. 27 mm. ♀♂. Length 11-12; expanse. 21-23 mm.

**Habitat:** All districts of South Gujarat



**Plate 3:** *Apis cerana indica* (Fabricius, 1793)

**4. *Apis dorsata* (Fabricius, 1793) (Plate 4)**

*Fabr. Ent. Syst.* ii, p. 328; *Smith, Cat.* ii, p. 415; *Horne, Trans. Zool. Soc.* vii, p. 181, pl. 22, fig. 3; *Dall. Torr. Cat.* x, p. 589. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀♂. Head, thorax, and abdomen, with short pubescence, more or less sparse or dense according to locality; the head and mesonotum finely punctured under the pubescence; short, medial, vertical groove below the anterior ocellus. Head, thorax, legs, and apical three segments of the abdomen black, more or less pale and fuscous all the hinder part of the thorax and on the abdomen; the basal three segments of the abdomen honey-yellow; pubescence fuscous on the head, thorax in front, legs above, and apical segments of the abdomen, pale ochraceous yellow on the hinder parts of the thorax and at the base of the abdomen; legs beneath, especially the posterior tibiae and tarsi, with short ferruginous pubescence; wings pale fuscous or fusco-hyaline.

♀ Similar; larger and darker. ♂ Similar; much darker, the eyes very large.

♀. Length 21; expanse. 36-37 mm. ♂. Length 17; expanse. 32 mm. ♀♂. Length 16-18; expanse. 30-35 mm.

**Habitat:** All districts of South Gujarat



**Plate 4:** *Apis dorsata* (Fabricius, 1793)

**5. *Apis florea* (Fabricius, 1787) (Plate 5)**

*Mant. Ins.* i, p. 305; *Dall. Torr. Cat.* x, p. 591. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀♂. Head, thorax, and abdomen dull and opaque, very minutely aciculate, slightly pubescent. Black; the basal two abdominal segments more or less red; the pubescence on the head and thorax white, on the posterior tarsi ferruginous golden; in fine specimens there are narrow transverse bands of silky white pile at the base of the 2<sup>nd</sup> to the 5<sup>th</sup> abdominal segments; wings hyaline and iridescent, nervures testaceous, tegulae black.

♀ similar, much larger; the anterior and intermediate tarsi, the posterior tibiae and tarsi, the basal three abdominal segments, and the apical margins of the 4<sup>th</sup> and 5<sup>th</sup> segments rufo-testaceous; the face and front with silky snow-white pile; the legs covered with a thin, short, glittering pale pubescence.

♂ Larger; black with dense long cinereous- white pubescence: the legs rufo-testaceous, the basal joint of the posterior tarsi swollen, with a remarkable curved lobe at base beneath. ♀ Length 13; expanse. 24 mm. ♂ Length 12; expanse. 24 mm. ♀♂. Length 8; expanse. 16 mm.

**Habitat:** All districts of South Gujarat



**Plate 5:** *Apis florea* (Fabricius, 1787)

#### 6. *Tarsalia strobilanthae* (Baker, 1998) (Plate 6)

Engel *et al.* (2017). *American Museum Novitates*, (3877): 1-28. <sup>[10]</sup>.

♀♂. Head wider than long, but face comparatively narrow, interocular distance less than compound eye length; vertex comparatively straight, not uniformly convex nor excavated between compound eyes and ocelli in facial view. Clypeus weakly to moderately protuberant in profile strongly bent back at side of labrum. Submental spine present. Pronotum without transverse carina. Mesotibial spur long, serrate, apex slightly incurved; mesobasitarsal comb absent. Metabasitibial plate short, wider than long, apically weakly and broadly rounded; metatibial spurs long, serrate, apices slightly incurved. Pretarsal arolium present. Forewing with pterostigma small, as long as wide, scarcely wider than prestigma; pterostigmal margin inside marginal cell weakly or not convex; marginal cell apex not truncate, bent away from anterior wing margin; three submarginal cells present; membrane with setae throughout. Hind wing with 2M+Cu one-half as long as M or less; cu-a transverse, more than one-half length of M; jugal lobe short, slightly less than one-half length of vannal lobe. ♀♂. Length: 5.5–13 mm

**Habitat:** Narmada, Surat, Navsari and the Dang



**Plate 6:** *Tarsalia strobilanthae* (Baker, 1998)

#### 7. *Tetragonula laeviceps* (Smith, 1858) (Plate 7)

*Trigona laeviceps*, Smith, *Jour. Linn. Soc.* ii (1858), p. 51, ♀. *Melipona laeviceps*, Dall. *Torr. Cat.* x, p. 580. (Ref.: Bingham, 1897) <sup>[9]</sup>

♀. Head, thorax, and abdomen smooth and shining, the front and vertex and the median segment very highly polished. Head and thorax black; the face and clypeus covered with a thin cinereous pile; the antennae, the clypeus anteriorly, and the legs rufo-testaceous; the abdomen testaceous, darkening to

castaneous brown on the apical three segments above; wings subhyaline, brilliantly iridescent. ♀. Length 4-5; expanse. 11 mm.

**Habitat:** All districts of South Gujarat



**Plate 7:** *Tetragonula laeviceps* (Smith, 1858)

#### 8. *Tetragonula iridipennis* (Smith, 1854) (Plate 8)

*Trigona iridipennis*, Smith, *Cat.* ii, p. 413, ♀♂. *Melipona iridipennis*, Dall. *Torr. Cat.* x, p. 579. *Trigona bengalensis*, *Cam. Mem. Manch. L. Ph. Soc.* xli, 1897 (Ref.: Bingham, 1897) <sup>[9]</sup>

♀♂. Head, thorax, and abdomen smooth and shining; the face in front, the sides of the thorax and of the median segment with a thick silky pile. Head and thorax black, the pile silvery; the labrum, mandibles, palpi, antennae, and apical joints of the tarsi testaceous, the sides of the mesonotum and the scutellum fringed with fuscous pubescence; the abdomen testaceous, darkening towards the apex; wings hyaline and brilliantly iridescent. ♀♂. Length 3-4; Expanse: 7-9 mm.

**Habitat:** The Dangs



**Plate 8:** *Tetragonula iridipennis* (Smith, 1854)

#### 9. *Tetralonia elegans*, (Smith 1854) (Plate 9)

Smith, *Cat.* ii, p. 302, ♂; Dall. *Torr. Cat.* x, p.232. (Ref.: Bingham, 1897) <sup>[9]</sup>

♂. Head, thorax, and abdomen densely pubescent; the clypeus nearly square, very slightly emarginate anteriorly, and very, lightly punctured; thorax above under the pubescence closely and more strongly punctured; abdomen with the apical margins of segments 1-5 non-pubescent and very finely aciculate. Black; the face below the base of the antennae, the clypeus, labrum, and mandibles at base yellow, the latter at apex and the 3<sup>rd</sup> and following joints of the flagellum of the antennae testaceous black; the face above, the bases of the antennae, the cheeks and occiput, the thorax, and base of the abdomen with pale fulvous-yellow pubescence, that on the

legs silvery; base of abdominal segments 2-4 with transverse fasciae of white, the 5<sup>th</sup> segment entirely covered with white, and the 6<sup>th</sup> and apical segments with fuscous pubescence; wings hyaline, faintly clouded at their apical margins. ♂. Length 10-11; expanse. 18 mm.

**Habitat:** Bharuch, Narmada, Navsari and the Dang



**Plate 9:** *Tetralonia elegans* (Smith, 1854)

**10. *Anthidium orientale* (Bingham, 1897) (Plate 10)**

*Cat.*, p. 495-496 (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head, thorax, and abdomen finely and very densely punctured, slightly shining; clypeus anteriorly transverse, fringed with somewhat stiff pubescence; scutellum rounded posteriorly; abdomen slightly curved, strongly convex above. Black; the base of the mandibles, the clypeus, the face on each side of it, a narrow stripe broadening above along the inner orbits almost to the top of the eyes, a spot below the anterior ocellus, a broad stripe on each cheek, nearly meeting on the posterior margin of the vertex, a stripe on each side of the mesonotum anteriorly, bent almost at a right angle and passing by the tegulae, a spot on the tegulae in front, a broad stripe on the posterior margin of the scutellum, interrupted in the middle, the apex of the femora beneath, the tibiae above (in the fore legs the tarsi above also), and broad transverse lateral spots on abdominal segments 1-5, bright yellow; the head, thorax, and abdomen with a sparse glittering pale pubescence; the pollen-brush white; wings hyaline, fuscous along the costal margin. ♀. Length 9; expanse. 16 mm.

**Habitat:** All districts of South Gujarat



**Plate 10:** *Anthidium orientale* (Bingham, 1897)

**11. *Coelioxys capitatus* (Smith, 1854) (Plate 11)**

*Cat.* ii, p. 267, ♀; *Dall. Torr. Cat.* X, p. 483. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head and thorax very broad, the former sub quadrate, both closely and very coarsely punctured; abdomen acutely conical, more finely punctured, the punctures on the basal segment densest; clypeus flat anteriorly, nearly transverse; scutellum with two minute medial teeth and a large blunt tooth on each side at the lateral angles posteriorly; apical abdominal segment acutely pointed, its dorsal plate medially carinate on its apical half, ventral plate acutely pointed and notched at extreme apex, projecting considerably beyond the dorsal plate. Jet-black; the clypeus thinly, the front, cheeks, two spots on the mesonotum anteriorly, two spots at the base of the scutellum, one on each tegula, the sides of the thorax, the legs more or less, and transverse fasciae, narrow in the middle, wide laterally, on the apical margins of abdominal segments 1-5 covered with dense white pile; the legs dark ferruginous; wings hyaline at base, fuscous towards their apical margins.

♂. Similar, the legs often black; apical abdominal segment armed with eight spinous teeth, one on each side at base and six terminal, four above and two below. ♀. Length 7; expanse. 13 mm. ♂. Length 6.5; expanse. 13 mm.

**Habitat:** All districts of South Gujarat



**Plate 11:** *Coelioxys capitatus* (Smith, 1854)

**12. *Coelioxys fuscipennis* (Smith, 1854) (Plate 12)**

*Cat.* ii, p. 266, ♀; *Dall. Torr. Cat.* X, p. 487. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head and thorax very closely punctured, cribrate; basal abdominal segments finely and closely punctured, 2<sup>nd</sup> and 3<sup>rd</sup> segment with a deep transverse groove in the middle above, the sides of the groove smooth and shining, the base of the segments coarsely and the apical margins finely punctured; segments 3-6 finely and closely punctured; clypeus subtriangular, transverse anteriorly, thinly pubescent; scutellum broadly rounded posteriorly, the lateral teeth narrow and acute; apical segment slightly flattened, the dorsal plate subacute, rounded posteriorly, with a medial longitudinal carina, and a broad shallow depression along the

lateral and apical margins; ventral plate acutely spoon-shaped, slightly longer than the dorsal plate. Black: the sides of the face, the front, cheeks, and transverse bands on the apical margins of segments 1-5 of the abdomen with dense, the clypeus and legs with thin snow-white pubescence; the transverse bands on the abdomen broadening greatly on the sides and beneath; wings fuscous, subhyaline towards their base. ♀. Length 12-13; expanse. 21-23 mm.

**Habitat:** All districts of South Gujarat



**Plate 12:** *Coelioxys fuscipennis* (Smith, 1854)

**13. *Coelioxys sexmaculatus* (Cameron, 1897) (Plate 13)**

*Mem. Manch. L. Ph. Soc.* xli, 1897 (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head on the vertex and front, pronotum, mesonotum, scutellum, the basal and the apical segments of the abdomen punctured, coarsely on the mesonotum, more finely and closely on the scutellum; the transverse furrow on the 2<sup>nd</sup> abdominal segment rugose; the apical segment with a central longitudinal carina, thickening towards the apex, which is depressed on each side of it; the scutellar spines stout. Black; the head in front and the sides of the thorax densely covered with snow-white pubescence; two spots at the base of the mesonotum, two smaller behind the tegulae, two at the base of the scutellum, a line on the apical margin of the 1<sup>st</sup> abdominal segment, a central longitudinal line on its ventral side, and the apical margins of the remaining ventral segments covered with white pubescence; tarsi of the legs with short golden pubescence; wings hyaline at base, fuscous towards the apex. ♀. Length 11 mm.

**Habitat:** All districts of South Gujarat



**Plate 13:** *Coelioxys sexmaculatus* (Cameron, 1897)

**14. *Lithurgus atratus* (Smith, 1853) (Plate 14)**

*Cat. i.*, p. 145, ♀; *Dall. Torr. Cat. X.*, p. 415. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head and thorax transversely rugose; abdomen shining, sparsely punctured, the punctures shallow; clypeus strongly punctured, produced into a triangular prominent tubercle at base, arched anteriorly, and fringed with a thick tuft of pubescence; the posterior tibiae coarsely rugose above; the 2<sup>nd</sup> abdominal segment constricted at base, the apical margins of segments 2-5 narrowly sub depressed. Jet-black; the apex of the clypeus, the face on both sides the pronotum, the sides and

apex of the median segment, and base of the abdomen with a thin soft white pubescence; the legs black with black pubescence; the apical margins of segments 1-5 fringed with white pubescence, on the basal segment this is broadly interrupted in the middle; the apical segment with black pubescence above; the pollen brush thin, from a brownish red to black in different specimens; wings fusco-hyaline, with a slight purple effulgence.

♀. Length 11-13; expanse. 20-24 mm

**Habitat:** All districts of South Gujarat



**Plate 14:** *Lithurgus atratus* (Smith, 1853)

**15. *Megachile (Eutricharaea) hera* (Bingham, 1897) (Plate 15)**

*Megachile panjaubensis* Cameron, 1906:p.135-136 ♂. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head, thorax, and abdomen minutely and very closely punctured; head broader than the thorax, flat, the cheeks not much developed; clypeus very slightly convex, rounded anteriorly, and with a small tubercle above its base; abdomen cordiform. Black; the sides of the clypeus, the front above the antennae, the sides of the thorax and the median segment with long soft white pubescence; the legs covered with short sparsely-set glittering white hairs; the base of the abdomen with long white pubescence, and the apical margins of segments 1-5 with a short white fringe of the same; pollen-brush white at base, fulvous on the apical four segments; wings hyaline and iridescent, nervures and tegulae testaceous brown.

**Habitat:** All districts of South Gujarat



**Plate 15:** *Megachile (Eutricharaea) hera* (Bingham, 1897)

**16. *Megachile (callomegachile) lerma* (Cameron, 1908) (Plate 16)**

*Megachile umbripennis* Smith, *Cat. i*, p. 175, ♀. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head, thorax, and abdomen closely punctured and pubescent; the disc of the clypeus, the vertex except round the ocelli, and the apical two-thirds of the 2<sup>nd</sup> and following abdominal segments bare; clypeus convex, transverse anteriorly; the margins of abdominal segments 1-5 narrowly depressed. Black; front, thorax, basal abdominal segment, and the base narrowly of the 2<sup>nd</sup> with dense fulvous pubescence; the 3<sup>rd</sup> segment with a narrow fringe of the same generally much obliterated, 4<sup>th</sup> and 5<sup>th</sup> segments with a narrow white lateral fascia; legs with black, the tarsi beneath of the posterior legs with fulvous pubescence; pollenbrush white with the apical portion black; wings hyaline at base, fuscous for the apical four-fifths of their length.

♀. Length 13 mm; expanse- 27 mm.

**Habitat:** Narmada, Navsari, the Dang and Valsad



**Plate 16:** *Megachile (Callomegachile) lerma* (Cameron, 1908)

**17. *Megachile bicolor* (Fabricius, 1781) (Plate 17)**

*Megachile bicolor*, *Lepel. Hym. ii*, p. 342; Smith, *Cat. i*, p. 181.

(Ref.: Bingham, 1897)<sup>[9]</sup>

♀ Head, thorax, and abdomen finely punctured; clypeus subtriangular, slightly convex, anteriorly transverse, with a broad medial shallow sulcation not reaching its base; abdomen elongate, cordate. Black; the sides of the face and clypeus with rather thick white pubescence, a spot of the same underneath the base of the wings; the median segment and abdomen above with rich fulvous red, the posterior lateral angles of the former with white pubescence; legs black, the pubescence fuscous, fulvous red on the underside of the intermediate and posterior tarsi; pollen-brush white; wings fusco-hyaline.

♂ Similar, smaller, head proportionately larger, wings lighter in colour; median segment and the intermediate and posterior tarsi beneath with golden yellow pubescence.

♀ Length 14-15; expanse. 30 mm. ♂. Length 1.2; expanse. 26 mm.

**Habitat:** All districts of South Gujarat except Valsad



**Plate 17:** *Megachile bicolor* (Fabricius, 1781)

**18. *Megachile disjuncta* (Fabricius, 1781) (Plate 18)**

*Megachile disjuncta*, Lepel. Hym. ii, p. 331; Smith, Cat. i, p.178. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀ Head, thorax, and abdomen densely and somewhat coarsely punctured, the margins of abdominal segments 1-5 broadly depressed, the middle of the 4<sup>th</sup> just before the depressed portion always, and of the 2<sup>nd</sup>, 3<sup>rd</sup>, and 5<sup>th</sup> segments very often smooth, shining, impunctate; the clypeus from the front subtriangular, its apical margin transverse; mandibles broad at apex, the outer tooth acute; vertex broad, flattish, produced back; the back of the head roundly emarginate. Black; the face and front, the prothorax at the sides and beneath, and the legs on the outside with black pubescence; the pubescence on the inside of the tibiae and tarsi fuscous; the median segment and the basal segment of the abdomen covered with thick long white to rusty-yellow pubescence; the pollen-brush jet-black; wings hyaline fuscous, for their apical three-fourths with a brilliant purple effulgence.

♂ Similar, smaller; the base, sides, and apex of the clypeus with long white pubescence.

♀. Length 16-17; expanse. 30-32 mm. ♂. Length 12; expanse. 24 mm.

**Habitat:** All districts of South Gujarat



**Plate 18:** *Megachile disjuncta* (Fabricius, 1781)

**19. *Megachile lanata* (Fabricius 1775) (Plate 19)**

*Megachile lanata*, Lepel. Hym. ii, p. 342; Smith, Cat. i, p. 177. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head, thorax, and abdomen finely and closely punctured and pubescent; the clypeus sublunate in shape, anteriorly transverse. Black; the head, except the clypeus broadly in the middle, the thorax, and basal two abdominal segments above covered with dense, and the legs with thin fulvous-red pubescence; the apical margins of segments 3-5 above with narrow transverse fasciae of white pubescence; pollen-brush white; antennae and legs nigro-piceous; wings flavo-hyaline, the apical margin broadly fuscous.

♂ similar, smaller, the pubescence on the clypeus and front paler, more golden in tint. ♀ Length 14-15; expanse. 26-28 mm. ♂ Length 12-13; expanse. 22 mm

**Habitat:** All districts of South Gujarat



**Plate 19:** *Megachile lanata* (Fabricius 1775)

**20. *Megachile stirostigma* (Cameron, 1913) (Plate 20)**

*Chalicodoma (callomegachile) stirostoma* Michener, 1965: p. 191 (Veereshkumar, 2015)<sup>[11]</sup>

♀. Body length 12- 14 mm; black clypeas median triangle and supraclypeal triangle much prominent; mandible tridentate, first and second segment equal in the length and interspace distance; second interspace distance long with incurved at third tooth, first labial segment larger than second.

♂. Body length 10-12 mm; black; clypeal apical margin truncate with concave medially, area behind apical margin slightly or not depressed; tridentate mandible without submedian processes; sparsely distributed long hairs on either side above the lateral apodeme, anterior margin concave medially with hairs, speculum v-shaped.

**Habitat:** Narmada, Navsari and Valsad



**Plate 20:** *Megachile stirostoma* (Cameron, 1913)

**21. *Braunsapis picitarsis* (Cameron, 1902) (Plate 21)**

*Allodape* Lepel, 1825. *Encycl. Mith., Ins.* x, p. 18. Type, *A. rufogastra*, Lepel. *Allodape (Braunsapis)* Michener, 1969. *J.*



*Kans. Entomol. Soc.* 42: p. 290 (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head transverse, nearly as wide as the thorax; ocelli three, in a triangle on the vertex; antennae filiform, geniculate, flagellum thickening towards the apex; tongue long; labial palpi 4-jointed, basal two joints elongate, the apical two minute; maxillary palpi 6-jointed, basal joint thick, about as long as the following two, apical three minute, subequal; labrum not notably longer than broad; mandibles narrow, acute. Thorax ovate; legs slender, short; wings moderately broad, fore wing with the radial cell constricted towards the apex and appendiculate two cubital cells, the 1<sup>st</sup> longer than the 2<sup>nd</sup>, the 2<sup>nd</sup> narrowed toward the marginal and receiving both recurrent nervures. Abdomen cylindrical, of moderate size.



**Plate 22:** *Ceratina binghami* (Cockerell, 1908)

**Habitat:** Bharuch Narmada, Navsari, the Dang and Valsad



**Plate 21:** *Braunsapis picitarsis* (Cameron, 1902)

**22. *Ceratina binghami* (Cockerell, 1908) (Plate 22)**

*Ann. Mag. Nat. Hist.* (8) 1: 340 (Ref. Prashantha, 2017)<sup>[12]</sup>

Description: ♂♀: Head, thorax, abdomen finely and closely punctured; clypeus elongate triangular, 1-5 marked with short obscure impressed line on each side of abdomen, abdomen slightly narrowed at base. Color of abdomen is shiny green; mandibles, labrum, antennae, legs, and impressed lines on thorax and abdomen black, legs sometimes with greenish or bluish tint some time covered with white pubescence. Thorax ovate, the radial cells on forewings are rounded at apex and wings hyaline. ♂♀. Length ranges between 15-18 mm.

**Habitat:** All districts of South Gujarat

**23. *Ceratina hieroglyphica* (Smith, 1854) (Plate 23)**

*Cat. ii*, p. 226, ♂♀; *Dall. Torr. Cat. x*, p. 199. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head above and the hollow on the front below the ocelli somewhat coarsely, the thorax and abdomen more finely punctured, the punctures on the abdomen emitting short decumbent hairs; the clypeus, disc of the mesonotum, and basal abdominal segment smooth and shining, the clypeus having a few scattered fine punctures; median segment narrowed at apex and rounded posteriorly. Black; a invert T-shaped mark on the clypeus, a lunate spot above it, a stripe on each side broadened below, a spot above each antenna, a broad stripe on each cheek, another on the pronotum, two parallel longitudinal lines on the mesonotum, another short one on each side over the tegulae, a broad squarish mark on the middle of the scutellum, the tubercles, the legs except the coxae, trochanters, and femora above, and transverse subapical fascia on the segments of the abdomen, yellow; the fascia on the 1<sup>st</sup> abdominal segment broadened in the middle and roundly incised anteriorly on each side, that on the 2<sup>nd</sup> broad, laterally attenuated on each side of the middle, the fascia on the 3<sup>rd</sup> segment broadly interrupted in the middle and widest laterally, on the 4<sup>th</sup> broadest in the middle where it is narrowly interrupted, the 5<sup>th</sup> segment with a broad truncate cone-shaped spot in the middle, the 6<sup>th</sup> segment black; legs slightly pubescent; wings hyaline, more or less fuscous; nervures and tegulae testaceous.

♂. Similar to the ♀, but with the yellow markings broader, the scape of the antennae in front and the anterior femora yellow.

♂♀: Length, 9-11; expanse. 16-17 mm.

**Habitat:** Narmada, Navsari, the Dang and Valsad



**Plate 23:** *Ceratina hieroglyphica* (Smith, 1854)

**24. *Ceratina smaragdula* (Fabricius, 1787) (Plate 24)**

*Ceratina viridis*, *Guer. (nec Latr.) Icon. Regn. Anim., Ins.* p.449, pl. 73, fig. 6; *Smith, Cat. ii*, p. 224. *Ceratina*

*viridissima*, *Dall. Torr. Cat. x*, p. 201. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀♂. Head, thorax, and abdomen finely and closely punctured,

granular; clypeus elongate triangular, margined all round, and with a medial longitudinal carina; mesonotum convex, with two medial parallel impressed lines, and an abbreviated impressed line on each side of and parallel to them; abdomen with segments 1-5 marked with a short obscure impressed line on each side above, just before the apical margin. Bright green, sometimes blue, metallic and shining; clypeus and a line on all the tibiae above yellow; mandibles, labrum,

antennae, legs, and the impressed lines on the thorax and abdomen black, the legs sometimes with a greenish or bluish tint and covered with hoary white pubescence; wings hyaline and iridescent, nervures and tegulae testaceous brown. ♀♂. Length 8-10; expanse. 16-17 mm.

**Habitat:** All districts of South Gujarat



**Plate 24:** *Ceratina smaragdula* (Fabricius, 1787)

**25. *Xylocopa aestuans* (Linnaeus, 1758) (Plate 25)**

*Xylocopa aestuans*, *Lepel. Hym.* ii, p. 193, ♀♂; *Smith, Cat.* ii, p. 353; *Dall. Torr. Cat.* x, p. 202. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head, thorax, and abdomen finely punctured, the thorax above densely pubescent, the disc of the mesonotum smooth and impunctate under the pubescence; clypeus flat, transverse in the middle anteriorly, the sides oblique; clypeus and front not carinate. Black; the pubescence on the head and face, on the sides of the thorax and beneath and on the abdomen black; on the thorax above it is bright yellow; wings dark fuscous with a purple effulgence.

♂. Black covered all over with a dense olive-yellow-pubescent, darker or paler according to locality, those from Sikkim, Burma, and Tenasserim being darker than specimens from the Punjab, N.W. Provinces, and Bombay; posterior tarsi with brown pubescence; wings hyaline.

♀ Length 21-23; expanse 41-48 mm ♂ Length 8-20; expanse 40-42 mm

**Habitat:** All districts of South Gujarat



**Plate 25:** *Xylocopa aestuans* (Linnaeus, 1758)

**26. *Xylocopa amethystina* (Fabricius, 1793) (Plate 26)**

*Fabr. Ent. Syst.* ii, p. 325; *Dall. Torr. Cat.* x, p. 204. *Xylocopa minuta*, *Lepel. Hym.* ii, p. 190. *Xylocopa ignita*, *Smith, Trans. Ent. Soc.* 1874, p. 276. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head and thorax anteriorly and on the sides and apex of the mesonotum finely and closely, abdomen sparsely punctured, the last with long soft thin pubescence on the

apical three or four segments; clypeus medially obscurely carinate; front between the antennae with a small but acute and prominent tubercle. Black with black pubescence; wings fuscous, with a deep purple lustre.

♂. similar, smaller; the clypeus and sides of the face and apex of the labrum yellowish white; the pubescence on the mesonotum anteriorly, on the sides of the thorax in front, and on the anterior tibiae and tarsi pale brown, almost cinereous on the tarsi; wings paler than in the female, in some specimens hyaline at base.

♀. Length 13-17; expanse. 37-39 mm. ♂. Length 12-14; expanse. 29-32 mm.

**Habitat:** All districts of South Gujarat



**Plate 26:** *Xylocopa amethystina* (Fabricius, 1793)

**27. *Xylocopa fenestrata* (Fabricius, 1798) (Plate 27)**

*Apis fenestrata*, *Fabr. Ent. Syst. Suppl.* p. 273, ♂  
*Xylocopa indica*, *Klug, Mag. n. Entd. ges. Naturk., Berlin*, i, 1807, p.264. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head finely and closely, thorax and abdomen more sparsely punctured, the disc of the mesonotum impunctate; clypeus very slightly convex, nearly flat, widely emarginate anteriorly; front not carinate; mesonotum with three obscure, parallel, longitudinally impressed abbreviated lines. Black, shining, the pubescence black, ferruginous along the apex of the anal abdominal segment, sparse except on the intermediate and posterior legs, where it is dense, long, and of a sooty black colour; third abdominal segment with sometimes a minute spiracular lateral impression near its base covered, with short yellow pubescence; wings dark fuscous,

with a purple and coppery effulgence, and with obscure hyaline lines between the nervures at base.

♂. Similar, narrower in shape, the wings paler, with the hyaline lines more clearly defined.

♀. Length 22-24; expanse. 46-50 mm. ♂. Length 21-22; expanse. 44 mm

**Habitat:** All districts of South Gujarat



**Plate 27:** *Xylocopa fenestrata* (Fabricius, 1798)

### 28. *Xylocopa latipes* (Drury, 1773) (Plate 28)

*Xylocopa latipes*, Fabr. Syst. Piez. p. 337; Smith, Cat. ii, p. 353; Dall. Torr. Cat. x, p. 213. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head, thorax and abdomen punctured; the clypeus, mesonotum anteriorly, and abdomen most densely so; front with two deep sulcations from below the base of the antennae to beyond the posterior ocelli, the division between forming a marked ridge and widening above to receive the anterior ocellus; scape of the antennae widened towards apex, Black, with black pubescence., thick and velvety on the mesonotum anteriorly, and long and tufted on the lateral margins of the abdominal segments; the pubescence on the posterior tibiae long, dense, and stiff; wings dark fuscous, with vivid coppery, green, and purple effulgence changing as they catch the light.

♂. similar, the sulcations on the front smaller; the eyes very large, meeting or nearly meeting on the vertex; scape of the antennae much broadened towards the apex; anterior tibiae and tarsi flattened and yellow, the tibiae twisted, the tibiae and tarsi fringed anteriorly and posteriorly with long, thick, somewhat curled hairs; intermediate and posterior legs longer in proportion; wings much narrower, the apex of the anterior wing acute. Some specimens have the clypeus and face below the antennae variegated with yellowish white.

♀♂. Length 32-35; expanse: 78- 80 mm.

**Habitat:** Bharuch, Narmada, Surat, Navsari and the Dang



**Plate 28:** *Xylocopa latipes* (Drury, 1773)

### 29. *Ceylalicthus variegatus* (Olivier, 1789) (Plate 29)

Pesenko, Y.A. 2000. *Entomological Review*, 80: 171-184<sup>[13]</sup>

♀. Head transversely elliptical in frontal view; Clypeus usually smooth or finely transversely aciculate, with few shallow pits, shiny; sometimes obscurely granulate, slightly shiny. Malar space linear, Emargination in inner orbits moderately deep, rounded; its depth nearly a third of extrapolated width of eye in frontal view. Clypeus provided with few large shallow pits, polished in interspaces. Supraclypeal area more densely roughened, lightly shiny. Frons densely and finely granulate, mat. Vertex granulose roughened, slightly shiny. Genal area with upper part usually densely punctate, finely roughened or smooth in interspaces, shiny; lower part, shagreened and striate, silk-mat. Mesoscutum more obscurely granulose punctate and shiny than that in female, on posterior half nearly smooth. Tegula hyaline. Wing membrane hyaline; veins and pterostigma light yellow; except for fuscous vein R1 and stripes along margins of pterostigma. Posterior areas of terga fuscous translucent.

♂. Similar; Head nearly rounded in frontal view; Median lobe of clypeus convex, its height equal to width or a little less; clypeus extending half of its length below eyes.

**Habitat:** Narmada, Surat, Navsari and the Dang



**Plate 29:** *Ceylalicthus variegatus* (Olivier, 1789)

### 30. *Halictus constrictus* (Smith, 1853) (Plate 30)

Cat. i, p. 63, ♂. (Ref.: Bingham, 1897)<sup>[9]</sup>

♂. Head, thorax, and abdomen very closely and finely punctured, on the scutellum the punctures are somewhat sparse, and on the abdomen very shallow; head in front elongate; clypeus much produced, truncate anteriorly; eyes wide apart, the inner orbits nearly parallel; front not carinate; antenna massive, as long as head and thorax united; median segment roundly truncate posteriorly, the lunate concavity as well as the sides punctured, with a granular appearance; abdomen elongate, longer than the head and thorax united. Black, the pubescence on the head and thorax white, tinged with fulvous, on the legs pale and glittering; the tibiae and tarsi of the anterior, and the apices of the tibiae and tarsi of the intermediate and posterior legs fulvo-ferruginous; the base of abdominal segments 2-5 with narrow transverse bands of white pubescence; wings broad and ample, hyaline and iridescent, nervures and tegulae dark testaceous. ♂. Length 7-8; expanse. 20 mm.

**Habitat:** All districts of South Gujarat except Tapi and The Dangs



**Plate 30:** *Halictus constrictus* (Smith, 1853)



**Plate 32:** *Halictus funebris* (Cameron, 1897)

**31. *Halictus fimbriatellus* (Vachal, 1894) (Plate 31)**

*Ann. Mus. Civ. Gen.* (2') xiv, p. 429, ♀. (Ref.: Dhanyavathi, 2009)<sup>[14]</sup>

♀. Head and thorax minutely and somewhat closely, abdomen more sparsely punctured, the basal segment smooth and shining clypeus lightly convex, elongate, interiorly fringed with stiffish hairs; postscutellum densely pubescent; median segment roundly truncate at apex above, slightly concave, finely rugose, punctate with a granular appearance. Dark castaneous brown, the tegulae and posterior margins of the segments paler, the latter lightly fringed with whitish down, the pubescence on the postscutellum fulvous, on the clypeus and face sparse and white; wings hyaline, nervures and stigma testaceous. Length 6; expanse. 12 mm.

**Habitat:** Narmada, Surat, Navsari, the Dang and Valsad



**Plate 31:** *Halictus fimbriatellus* (Vachal, 1894)

**32. *Halictus funebris* (Cameron, 1897) (Plate 32)**

*Mem. Manch. L. Ph. Soc.* xli, 1897 (Ref.: Dhanyavathi, 2009)<sup>[14]</sup>

♂. A Head and thorax finely and closely and the abdomen more minutely punctured; median segment short, truncate at apex, bounded at the sides, the enclosed space at its base the scutellum, and postscutellum reticulate; abdomen long broadening towards apex; head, thorax above and on the sides somewhat thickly pubescent. Jet-black and shining, the pubescence fuscous; wings hyaline the nervures and tegulae dark brownish black. ♂. Length 9; expanse. 18 mm.

**Habitat:** All districts of South Gujarat except Bharuch and Valsad

**33. *Halictus gutturosus* (Vachal, 1894) (Plate 33)**

*Ann. Mus. Civ. Gen.* (2') xiv, p.439, ♂. (Ref.: Dhanyavathi, 2009)<sup>[14]</sup>

♂. Head and thorax finely but not closely punctured, shining; abdomen smooth, the basal segment highly polished; head slightly elongate in front, the eyes very slightly convergent below; median segment roundly truncate posteriorly, the lunate space at base small, rugose. Black, with an obscure chalybeous tint in certain lights; the clypeus and front, the pronotum, sides of the thorax, and the abdomen beneath covered with a thin, the postscutellum with a dense greyish-white pubescence; wings hyaline, iridescent, nervures piceous.

♂. Length 6.5; expanse. 12 mm.

**Habitat:** Bharuch, Narmada, Navsari and the Dang



**Plate 33:** *Halictus gutturosus* (Vachal, 1894)

**34. *Halictus lucidipennis* (Smith, 1853) (Plate 34)**

*Cat.* i, p. 62, ♀. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Length 4.5 mm. Brassy green, head and thorax closely and finely punctured, antennae wanting; the face covered with short white pubescence, and the clypeus ciliated with white hairs. Thorax-the postscutellum covered with a short downy white pubescence, on the sides it is longer but of the same colour, the enclosed space at the base of the metathorax finely reticulate, the sides smooth and shining; wings clear hyaline and beautifully iridescent, nervures and tegulae very pale testaceous; legs rufo-testaceous, the anterior tibiae and the intermediate and posterior tarsi pale rufo-testaceous, their

pubescence white. Abdomen ovate, finely punctured, the apical margins narrowly testaceous and having pale marginal fasciae; the anal rima slightly fulvous; beneath testaceous.

♂. Sculptured and coloured as in the female; the antennae pale fulvous, about the length of the head and thorax, fuscous above; all the tibiae pale and the margins of the abdominal segments much depressed.

**Habitat:** Surat, Navsari, the Dang, Tapi and Valsad



**Plate 34:** *Halictus lucidipennis* (Smith, 1853)

**35. *Halictus rugolatus* (Smith, 1853) (Plate 35)**

*Cat. i*, p. 62, ♀. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. The head and disk of the thorax nigro-aeneous, the metathorax black; head closely and finely punctured; the clypeus black, shining and irregularly deeply punctured. Thorax more strongly punctured than the head, the metathorax truncate and roughly sculptured, the sides and beneath rugose; the tibiae and tarsi above clothed with pale fulvous pubescence, that beneath is deeper in colour; the wings subhyaline, iridescent, the nervures rufo-testaceous. Abdomen elongate-ovate, the basal segment very smooth and shining, the rest delicately punctured, the apical margins smooth, shining, and rufo-testaceous; at the basal margins of the second and third segments laterally a patch of white pubescence, on the fourth a more or less interrupted fascia; the apex covered with fulvous pubescence. ♀. Length 7.5 mm

**Habitat:** Bharuch, Narmada, Tapi, Navsari and the Dang



**Plate 35:** *Halictus rugolatus* (Smith, 1853)

**36. *Hoplonomia elliotii* (Smith, 1875) (Plate 36)**

*Trans. Ent. Soc.* 1875, p. 44, ♀♂; *Dall. Torr. Cat.* x, p. 166.

(Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head and thorax closely and finely punctured, more sparsely and coarsely on the scutellum; abdomen smooth, opaque, the bases of the segments only punctured; clypeus flat, carinate down the middle, transverse anteriorly; the scutellum with a more or less deep notch, or bituberculate posteriorly; the postscutellum with two teeth or spines in the middle posteriorly; the space at the base of the median segment finely punctured, the basal four abdominal segments with transverse impressed lines across the middle. Black, the head and thorax with a white somewhat griseous thin pubescence, the legs with pale glittering dense pubescence; the teeth on the postscutellum dark chestnut brown; the basal four abdominal segments with bright emerald green transverse fascia on their apical margins; wings hyaline, slightly fuscous along their apical margins.

♂. Similar; the tubercles at the lateral angles of the scutellum and the medial spines on the post scutellum more prominent; the posterior femora greatly swollen, the tibiae flattened, the apex on the inner side produced into a blunt testaceous process. ♀. Length 11-12; expanse. 22-23 mm. ♂. Slightly smaller.

**Habitat:** All districts of South Gujarat



**Plate 36:** *Lasioglossum (Ctenonomia) serenum* (Cameron, 1897)

**37. *Lasioglossum (Ctenonomia) serenum* (Cameron, 1897) (Plate 37)**

*Halictus serenus*, *Cam. Mem. Manch. L. Ph. Soc.* xli, 1897.

(Ref.: Bingham, 1897)<sup>[9]</sup>

♂. Head and thorax somewhat thickly pubescent, beneath the pubescence opaque; abdomen smooth, slightly shining; median segment with the enclosed semicircular space at base large and coarsely reticulate, the rest of the segment above and on the sides slightly punctured and pubescent; abdomen sub cordate, the segments above, in a strong light, appear to be very finely and closely punctured. Black; the pubescence white, golden yellow on the legs; the basal segment of the abdomen rufo-fuscous, with a fuscous transverse stripe above; wings hyaline, nervures and tegulae pale testaceous.

♂. Length 5; expanse. 12 mm.

**Habitat:** All districts of South Gujarat except Narmada



**Plate 37:** *Hoplonomia elliotii* (Smith, 1875)

**38. *Lipotriches (Nomia) fervida* (Smith, 1875) (Plate 38)**

*Trans. Ent. Soc.*, p. 55, ♂, pi. ii, fig. 12; *Dall. Torr. Cat.* x, p. 166. (Ref.: Bingham, 1897)<sup>[9]</sup>

♂. Head on the vertex, thorax, and abdomen closely and finely punctured, opaque; clypeus very slightly convex, rounded anteriorly; median segment truncate posteriorly, the sides slightly compressed, the space at base moderately wide, coarsely reticulate. Black, the antennae fulvous; the femora beneath, the tibiae and tarsi yellow; the clypeus and front up to the anterior ocellus, the cheeks, a broad transverse band on the mesonotum anteriorly, a line over the tegulae, the postscutellum, the sides of the thorax and of the median segment, and broad transverse bands on the apical margins of the 1-6 abdominal segments covered with dense very short pale fulvous pubescence; the posterior femora and tibiae swollen and incrassate, the former each with a tooth on the inside, the latter each with a castaneous spot on the outer and inner side near the base; wings hyaline, slightly fuscous. ♂. Length 10; 18 mm.

**Habitat:** Bharuch, Narmada, Navsari, the Dang and Valsad



**Plate 38:** *Lipotriches (Nomia) fervida* (Smith, 1875)

**39. *Lipotriches fulvinerva* (Cameron, 1907) (Plate 39)**

*Nomia aurifrons*, Smith, *Trans. Ent. Soc.* 1875, p. 43, ♀; *Dall. Torr. Cat.* x, p. 164. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head densely and finely, thorax minutely punctured; abdomen almost impunctate, slightly shining; clypeus transverse, convex, broadly arched anteriorly; median segment very short, broad and steep, the space at base very narrow, coarsely longitudinally rugose; abdomen oval, massive, convex above. Black; the legs testaceous, the coxae and femora often rufo-testaceous the clypeus, front, cheeks, and occiput with pale golden pubescence; the thorax, legs, and apical margins of abdominal segments 1-5 with pale yellowish pubescence, very bright and glittering on the legs; the margins of the segments under the pubescence pale

testaceous; the flagellum of each antenna beneath and at apex fulvous; wings hyaline, sometimes light flavo-hyaline, with a very pale fuscous cloud at apex of the fore wing. ♀. Length 8-10; expanse. 19-20 mm.

**Habitat:** All districts of South Gujarat except Surat and Valsad



**Plate 39:** *Lipotriches fulvinerva* (Cameron, 1907)

**40. *Lipotriches pulchriventris* (Cameron, 1897) (Plate 40)**

*Cam. Mem. Manch. L. Ph. Soc.* xli, 1897. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head, thorax, and abdomen very finely and closely punctured; the face in front below the anterior ocellus, the cheeks and occiput, a line on the pronotum down to the tubercles, the lateral and posterior margins of the mesonotum, the postscutellum, the median segment except on the semicircular enclosed space at base, the legs, the base of the abdomen, and transverse bands on the posterior margins of the segments, more or less densely pubescent; median segment short, posteriorly rounded, the enclosed space at base rugose; abdomen with the base of the 2<sup>nd</sup> segment strongly and of the other segments slightly constricted. Black; the pubescence yellow; the antennae reddish brown, the 2<sup>nd</sup> joint of the flagellum beneath, the underside of the tibiae, and the tarsi testaceous yellow; wings light flavo-hyaline, the apical margins broadly fuscous, nervures and tegulae testaceous.

♂. Similar, but with the basal segment of the abdomen narrowed at its base, almost petiolate; the wings with scarcely any tint of yellow, and the legs of a lighter colour.

♀. Length 10; expanse. 21 mm. ♂. Length 9-10; expanse. 21 mm.

**Habitat:** Narmada, Navsari and the Dang



**Plate 40:** *Lipotriches pulchriventris* (Cameron, 1897)

**41. *Nomia crassipes* (Fabricius, 1798) (Plate 41)**

*Nomia curvipes*, Fabr. *Ent. Syst.* ii, p. 310, ♂; Smith, *Trans. Ent. Soc.* 1875, p. 42, ♀♂, pl. i, fig. 8; *Dall. Torr. Cat.* x, p. 165. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head and abdomen lightly but closely, thorax densely and more coarsely punctured; clypeus slightly convex, transverse anteriorly; median segment somewhat coarsely punctured, rounded at the sides, the apex concavo-truncate; the narrow space along the base coarsely longitudinally striate. Black, the antennae and legs testaceous brown, the scape of the former pale, the front and legs covered with pale glittering pubescence, the thorax and median segment with dense fulvo-ferruginous pubescence; the apical margins of abdominal segments 1-4 bright greenish yellow, smooth and shining; wings fulvo-hyaline, fuscous along their apical margins, nervures and tegulae rufo-piceous.

♂. Similar; the posterior femora immensely swollen, the tibiae broadened towards the inner side produced into an acute angle; abdomen with the apical margin of the 5<sup>th</sup> segment also broadly yellow; apical halves of the femora, the tibiae, and tarsi yellow, the coxae, trochanters, and base of the femora black.

♀♂. Length 11- 12; expanse. 22 mm.

**Habitat:** All districts of South Gujarat



**Plate 41:** *Nomia crassipes* (Fabricius, 1798)

**42. *Nomia iridescens* (Smith, 1858) (Plate 42)**

Smith, *Jour. Linn. Soc.* ii, 1858, p. 43, 2; *Dall Torr. Cat.* x, p. 167. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head, thorax, and abdomen very minutely and densely

punctured; clypeus convex, with coarser punctures, and a medial sharp vertical carina, its anterior margin transverse; mesonotum broad slightly convex, and in certain lights showing several fine abbreviated longitudinally-impressed parallel lines on the disc; enclosed space at base of median segment longitudinally rugose. Black, the head and thorax opaque; the abdomen shining iridescent in certain lights, segments 2-4 with transverse bright green or blue fasciae on their apical margins, the pubescence on the head and thorax and legs griseous with a fulvous tint, most dense on the sides of the face, the cheeks, and the sides of the median segment; wings hyaline and iridescent, nervures and tegulae testaceous.

♂. Similar; the pubescence on the face more dense, the legs longer with more sparse pubescence, the posterior femora and tibiae only slightly swollen, abdominal segments 2-5 with bright green or blue fasciae; the whole abdomen more cylindrical, not so broad as in the female.

♀♂. Length 8-10; expanse. 17-20 mm.

**Habitat:** Narmada, Surat, Navsari, the Dang and Valsad



**Plate 42:** *Nomia iridescens* (Smith, 1858)

**43. *Pseudapis oxybeloides* (Smith, 1875) (Plate 43)**

*Trans. Ent. Soc.*, p. 42, ♀♂, pl. i, fig. 6, 6 a; *Dall. Torr. Cat.* x, p. 168. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head densely and finely, thorax more sparsely and coarsely punctured; abdomen shining; clypeus anteriorly slightly arched, flat; tegulae very large, longer than broad; median segment rounded at the sides, steeply truncate posteriorly and more closely punctured than the mesonotum, the space at base very narrow, with a row of single deep coarse punctures; each of the basal three abdominal segments above with an obscure transversely impressed line. Black; the apical joints of the tarsi and sometimes the whole of the posterior tibiae and tarsi testaceous; the clypeus and head in front, the legs on the outside, a line on the pronotum, the postscutellum, and the margins of the abdominal segments with glittering silvery-white pubescence, the pubescence on the thorax often fulvous.

♂. Similar, smaller, the pubescence with a fulvous tint; the posterior femora and tibiae much swollen, the inferior apical angle of each of the latter produced into a flat, long process, testaceous white in colour, rounded on the outside, the inner border straight; wings in both sexes hyaline, nervures and tegulae testaceous. ♀♂. Length 6.5-8; expanse. 14-16 mm.

**Habitat:** Bharuch, Narmada, Surat, and Navsari



**Plate 43:** *Pseudapis oxybeloides* (Smith, 1875)

**44. *Sphecodes fumipennis* (Smith, 1853) (Plate 44)**

Smith, *Cat. i*, p. 36, ♀.; *Dall. Torr. Cat. x*, p. 4. (Ref.: Bingham, 1897)<sup>[9]</sup>

♀. Head and thorax densely coarsely cribrate; abdomen shining, much more finely and sparsely punctured; clypeus convex, transverse anteriorly, the margin hidden by a fringe of stiff hairs; median segment truncate posteriorly, with the deep cribrate punctures confluent and larger than on the mesonotum, the space at base very coarsely longitudinally rugose; apical margin of basal abdominal segment constricted. Head, thorax, and legs with the apical two segments of the abdomen sometimes black, rest of the abdomen, generally the entire abdomen, ferruginous red; the clypeus, the sides of the face, the cheeks, and the legs, with sparse silvery white pubescence; wings fuscous, slightly paler towards the base.

♂. Precisely similar; the punctures on the head and thorax deeper, closer, and coarser. ♀♂. Length 11-12; expanse: 22-23 mm.

**Habitat:** Bharuch, Narmada, Tapi, Navsari and the Dang



**Plate 44:** *Sphecodes fumipennis* (Smith, 1853)

Description of various insect pollinators has been given by Bingham (1897)<sup>[9]</sup>, who described 288 species of bees under 30 genera from erstwhile British India. The genus *Tarsalia* is available in South Gujarat, which was first time reported as a

new genus from the Arabian Peninsula by Engel *et al.* (2017).<sup>[10]</sup> Veereshkumar (2015)<sup>[11]</sup> documented 52 species of Megachilidae with detailed descriptions of species along with illustrations and identification keys to tribes, genera, and species. In addition to these, the work of Prashantha, (2017)<sup>[12]</sup> and Pesenko (2000)<sup>[13]</sup> was repeatedly utilized during the course of investigations for identification of different pollinators collected from South Gujarat. Results of current work is also in confirmation with the work of Dhanyavathi 2009<sup>[14]</sup> who published a photographic catalogue of 55 species in 16 genera under three families *viz.* apidae, halictidae and megachilidae with the genera *Amegilla*, *Braunsapis*, *Ceratina*, *Xylocopa*; *Halitus*, *Lasioglossum*, *Nomia*, *Coelioxys*, *Megachile* and *Anthidium* illustrated and described with keys for its identification. However present work is in contrast with the work of Dhanyavathi 2009<sup>[14]</sup> who also reported genera like *Thyreus*, *Nomioides* *Heriades* *Eoanthidium* and *Euaspsis*, as that were not recorded from South Gujarat, it might be due to underprivileged exposure to the area of study.

**Conclusion**

For the elimination of the lacuna in the identification of pollinators present in South Gujarat, the photographic catalogue was prepared as a tool for the identification and conservation of existing pollinators of the region.

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