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Character visualization of *Pycnoscelus* sp. (Blattodea: Cockroach) in household organic waste composter in Surabaya

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ABSTRACT

Cockroaches are commonly found and contribute greatly on decomposition process in an organic waste treatment plant. Cockroach characterization is important for identification, while data of Indonesian cockroach visual characters is rare. This study aims to provide information regarding *Pycnoscelus* cockroaches through character visualization of local household cockroaches in Surabaya. This study was an observational study of cockroaches in the urban organic waste processing plant in Surabaya. Cockroach specimens were obtained by Berlese Funnel extraction method from garbage samples. Character visualization was done using a camera in a mini studio. Morphological characters observed were the body, legs, antennae and mouth. Information provided by this report can complement the availability of basic data on the diversity of Indonesian cockroaches.

Key words: *Household organic waste, Morphological characters, Pycnoscelus, Surabaya*

Introduction

Indonesia is one of mega biodiversity countries in the world that has high fauna diversity including insects. Insect isunique because it has the number one of diversity. Geographically, Surabaya has tropical climate, consequently the temperature and humidity condition are suitable for soil insect population to grow (Mullen and Durden, 2019).

The overflowing factors of soil insects were not only due to the temperature, it was also supported by water and their food sources from organic waste. The organic waste, in particular, compost, in Surabaya was from kitchen waste, traditional market waste, food and agricultural industry waste, and household waste. By those resources, cockroach has a potential to decompose organic waste, thus cockroach was abundantdue to the factors (Roth, 1998; Bell *et al.*, 2007).

In general, cockroach has flattened and broadly oval body, pronotum like a shield, chewing mouthparts, and segmented antennae. The cockroach is part of Dictyoptera, super order group which consist of insects with net wing and short ovipositor

(Bell *et al.,* 2007; Chinery, 2007). Indonesian cockroach collection was invented in the Leiden Museum and others museum (Bruijning, 1948). That cockroach from Indonesia, commonly, in the museum was identified as *Pycnoscelus surinamensis*, that was collected from Padang, Java, Sumatera, Bogor and Yogyakarta. In genus *Pycnoscelus*, it has some species variant; there are 15 species, for example, *P.surinamensis*, *P.indicus*, and *P.striata* (Bruijning, 1948). But all species that was recorded in the Leiden Museum and others, have no character visualization.

The lack of cockroachesinventory in Indonesia emphasized the need for character visualization. Surabaya, in particular has abundance of cockroach population which make it the suitable place to conduct this research. The visualization results give more information and reveal more aspects for the further researches. This study aims to provide information on the introduction of *Pycnoscelus* through character visualization of cockroaches from local household organic waste composter in Surabaya.

Material and Methods

Material preparation

Compost sample was collected from three layer of household organic waste (surface, middle, and lower layer). It was acclimated for two weeks withtemperature 26 to 31 ºC, pH 5 to 6, and moisture 50 to 60 % in microcosm.

Berlese Funnel was made from iron cylinder and aluminium cone. Berlese Funnel has size with the cylinder diameter 25.5 cm and height 50 cm, the aluminium cone diameter 26 cm and height 35 cm, and the upper filter mesh has diameter 16 cm with size 0.25 cm each square and the nether filter mesh has diameter 15 cm with size 1cm each square.

Cockroach collection

Extraction method was used Berlese Funnel with added 1kg organic waste from three different layer (surface, middle, and lower). It was processed for one week with temperature and light from 25 w bulbs (Fig. 1). In the bottom of mesh, Beaker glass filled alcohol 70 % that was used to collect and preserve the cockroaches.

Character visualization and identification

Cockroach that collected was anesthetized for 5 minutes with 90 % chloroform in closed Beaker glass. The cockroaches then observed down to detailed body parts. Digital camera was used to capture the morphology visual After that, all the characters recorded were analyzed to identify the cockroach species using identification literature.

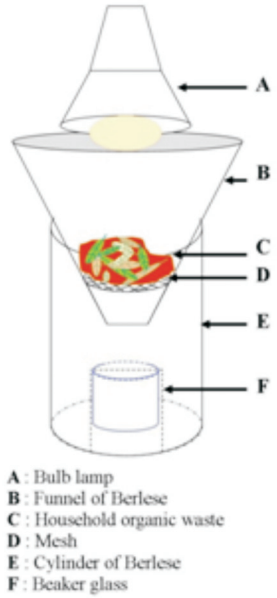

Fig. 1. Scheme of Berlese Funnel for compost sample extraction.

Result and Discussion

Extraction process

From extraction of three-layer compost, the genus of insects were obtained with cockroaches as the dominant groups. The cockroach was the dominant insect because the household waste has complex nutrients, for instance, carbohydrate, protein, and lipid that were used for growth, tissue maintenance, metabolism, and reproduction (Chapman, 2013; Mullins, 2015; Mullen and Durden, 2019). The cockroach spawn, oothecae, usually contain 5 to 40 embryos with egg shell whose color range from light brown to chestnut brown, depending on sclerotization (Mullen and Durden, 2019). The number of egg laid, larval feeding sites, larval mortality rates, and oviposition sites was affected by soil texture, moisture, and temperature (Andersen, 1987).

The abundance of cockroach in sample was affected by the interspecific and intraspecific food competition (Andersen, 1987). Furthermore, as fossorialorganism, cockroach showed specific behaviour such as light and heatsensitivity to pro-

tect them from desiccation (Labandeira and Beall, 1990). The burrowing organism behaviorof cockroach was apparent during the sampling, in the afternoon the cockroaches moved from the surface to the lower layer and trapped in the Berlese Funnel.

Cockroach identification

Cockroach sample was observed for their morphological detail (Fig. 2), cockroach sample has head with chewing mouthparts, pair of antennae, pair of eye and ocelli,and connected with pronotum, body with thorax and cerci at abdomen, six legs with spines at femur, and two pairs wing with venation at hind wings. Venation wing is wing type with large axillary area and it can fold like fan (Bruijning, 1948). Generally,the characteristics of cockroach sample are wings well developed, hind wings in anal area folded like a fan, fronts flat, brownish color, not bulging and living outside in litter, and those all general character was similar toBlaberidae family (Johnson and Triplehorn, 2004). The pronotum has blackish brown with yellowish line in lateral and it was remark of *Pycnoscelus surinamensis* (Roth, 1998).

This cockroach was expected as genus *Pycnoscelus* because it has morphological character of *P. indicus* species-group. The *P. indicus*species-group character that has in sample is dark pronotum with a broad anterior and narrow anterolateral yellowish band (Roth, 1998). Furthermore, all specimens obtained were female, indicating that the sample can be identified as *P. surinamensis* which mostly reproduce bythelytokous parthenogenesis and very rare by mating (this mating case was crossing from different culture, Indonesian bisexual × Hawaiian bisexual, it was produced male with nonfunctional reproduction) (Roth, 1967 and 1970).

The modified key identification of *Pycnoscelus surinamensis* (modified from Roth (1967 and 1998) and Choate.

1. Ventral margins of femora supplied with numerous spines……...2
- Ventral margins of femora unarmed, with only a few distal spines, or only posterior femora armed with spines……...……...4
2. Front wings not reduced, with discoidal (cubital) sections oblique and extending to hind margin of front wings…..……..*Supellalongipalpa* (Fabricius)
- Front wings reduced or not; if latter, then with longitudinal discoidal (cubital) sections extending to apex of front wings….……..3
3. Hind wings with costal veins strongly clubbed apically…….*Cariblattalutea*
- Hind wings with costal veins normal, not clubbed apically……...……*Symploce*
4.Front and hind wings reduced or not; some species with wings completely absent, but if hind wings present, anal field not folded fanwise; general surface hairy…….5
- Front and hind wings not reduced, anal section of hind wings folding fanwise; general surface hairless…….…….6
5. Front wings not reaching to middle of abdomen; pad between claws absent; size large (over 30mm)…….*Hemiblabera*tenebricosa (Rehn and Hebard)
- Front and hind wings extending beyond apex of abdomen; pad present between claws; size smaller (under 7 mm) ……...….*Holocompsanitidula* (F.)
6. Fourth tarsomere only with a ventral pad; hind wings with an aninterclaated triangle or appendicular field…….…7
- Four basal tarsomeres each with a ventral pad; wings without an intercalated triangle or appendicular field…….…8
7. Tarsal claws single but asymmetrical; hind wingwith an intercalated trinagle of length equal to notmore than one-third total wing length……..*Chorisoneura*
- Tarsal claws equal but with 2 microscopic teeth on eachinternal margin; hind wing with a reflexed appendicularfiled of length equal to approximately one
half total wing length……*Plectopterapoeyi* (Saussure)
8. Pad between claws absent; size extremely large (over 40mm); pronotumsubelliptical……..*Blaberus*
- Pad between claws present; size medium (under 30mm); pronotum produced posteriorly obtuseangulate, apex rounded……9
9. General color light Paris green; front wings not pitted…….*Panchloranivea* (L.)
- General color brown……10
10. Pronotum not dark with a broad anterior and narrow anterolateral yellowish band…….11
- Pronotum dark with a broad anterior and narrow

anterolateral yellowish band……..……12
11. Head and pronotum predominantly black; epigean……*Pycnoscelusnigra*
- Head and pronotum predominantly reddish brown; epigean or cavernicolous ……*Pycnoscelusstriatus*
12.Mostly bisexual; functional male reproduction bisexual mating reproduction……*Pycnoscelusindicus*
- Mostlyfemale or bisexual;nonfunctional male reproduction; parthenogenesis reproduction…...……*Pycnoscelus surinamensis*

Pycnoscelus surinamensis

The role of cockroach in wildlife is detritivore of an organic material, sometimes also being pest, or animal parasite transport host, for example chicken eyeworm (Schwabe, 1949). Among five families of cockroach worldwide, two families are Cryptocercidae which are wood detritivores with gut symbionts and Polyphagidae which live in arid area and can move rapidly on desert. While the other three families, Blaberidae, Blattidae, and Blattelidae, are often considered as pests. *P.*

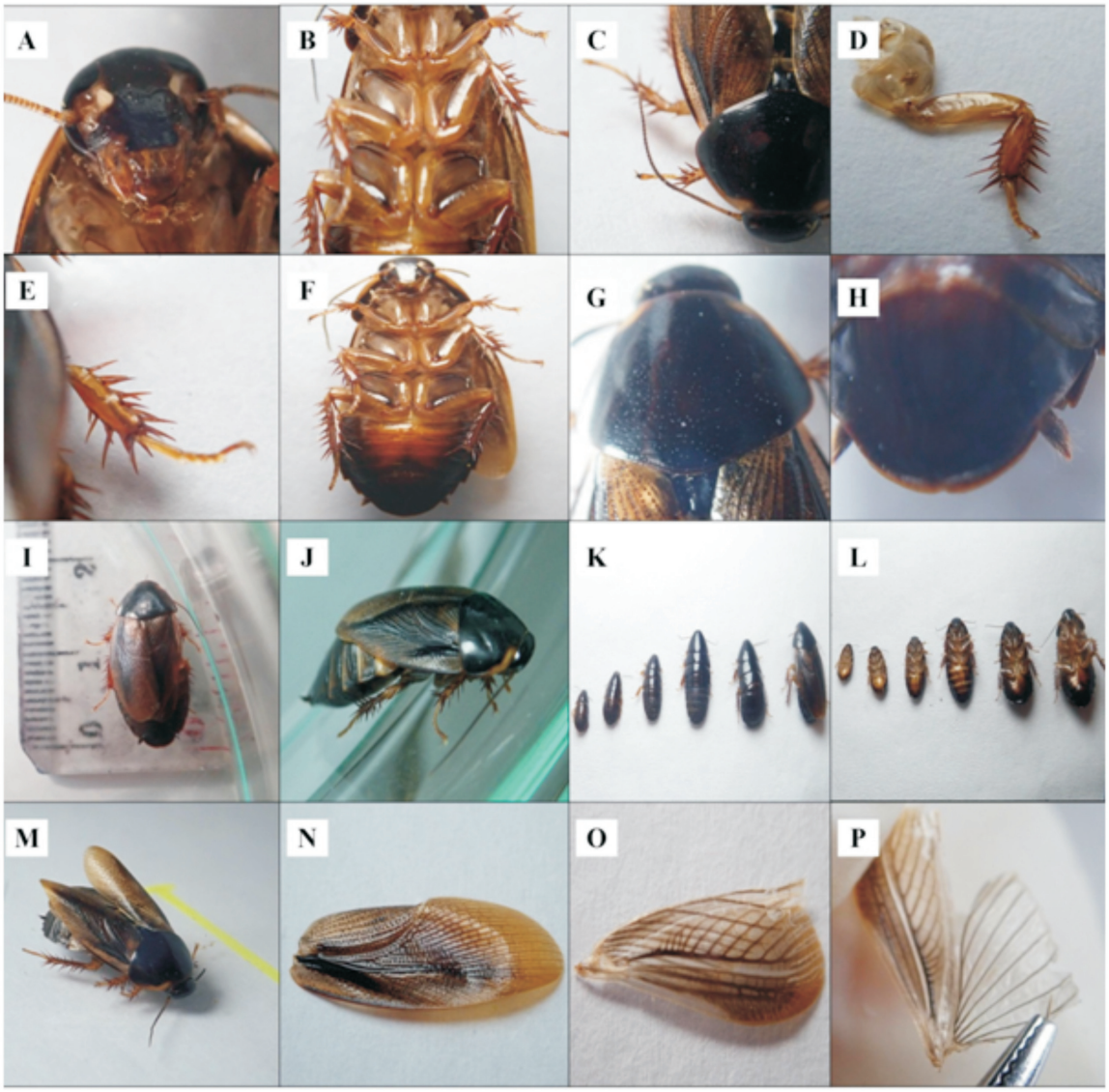

Fig. 2. Cockroach visual character. (**A**) Head with chewing mouthparts; (**B**) Thorax; (**C**) Antennae; (**D**) Whole leg; (**E**) Femur with spines; (**F**) Ventral body; (**G**) Pronotum; (**H**) Cerci; (**I**) Dorsal body; (**J**) Lateral body; (**K**) All size body from dorsal; (**L**) All size body from ventral; (**M**) Whole body with open wings; (**N**) Upper wing; (**O**) Lower wing; (**P**) Open the lower wing.

surinamensis which collected in this experiment is the member of Blaberidae family (Johnson and Triplehorn, 2004; Brenner and Krame, 2019).

P. surinamensis was commonly found in Indo-Malayan area or circumtropical area (Roth, 1998; Brenner and Krame, 2019) which include Surabaya, East Java, Indonesia. However previous reports by Roth (1998), and Brenner and Krame (2019) did not mention the presence of this species in Surabaya.

P. surinamensis has symbiotic association with other organisms, such as bacteria, protozoa, fungi, and plant. The example of microorganisms that associated with *P. surinamensis* are *Serratiamarcescens* (bacteria), *Mucor* sp. and *Herpomyces stylopygae* (fungi), and particular species of ciliates, flagellates, and gregarines (protozoa). *P. surinamensis* is host for helminths, *Severianoia severianoi* and *Oxyspirura mansoni*. *P. surinamensis*isa prey for *Centruoideshentzi,C. vitattus*, *Histiostomaferoniarum*, *Caloglyphusspinitarsus*, *Tyrophaguslintneri*, *Sarcophagalambens* and some species of mites. *P. surinamensis* forms commensalism association with plants (*Alsophila* sp., *Saccharumoficinarum*, *Aerocomiaaculeata*, *Cocosnuciferus*, *Ananascomosus*, easter lilies, *Musa* sp., *Rosa* sp., *Tribalus* sp., *Poinsettia* sp., *Nicotiana* sp., *Solanumtuberosum*) and insects (*Ampulexcompressa* and *Pheidolemegachepala*) (Roth and Willis, 1960).

Based on the result in this research,*P. surinamensis* that was found in compost sample in Surabaya, despite the species is known to be host of parasitic organisms, however with appropriate management, can be employed in the organic waste processing. Moreover, the symbionts of *P. surinamensis* can be further explored for hydrolytic enzymes that involved in organic material degradation, including the recalcitrant cellulosic materials. Further exploration in biotic association, molecular biology, and method for application of this species are needed for optimum utilization in the organic waste processing plant.

Conclusion

Cockroach species that was identified as *P. surinamensis* based on visual identification, was isolated from organic waste processing plant. This result would provide valuable information for further research on *P. surinamensis* in Surabaya.

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