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The Modern Systematic Status of Insects

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Annotation: This article discusses the current state of insect systematics, various hypotheses proposed by scientists, and the taxonomic groups that have undergone changes along with the reasons for these revisions.

Keywords: Insect, classification, class, order, systematics, phylogeny.

Presently, insects represent one of the largest classes in the animal kingdom — ranking first among animals and second only to plants in terms of species diversity. Numerous studies on this class have led to changes in the taxonomic status of many orders. The development of science and the introduction of modern methods and research approaches by scientists serve as evidence of this progress [28].

As a result of extensive research on insect systematics, the number of orders within this class has been revised several times. This article highlights the current state of insect systematics and their classification into different orders. According to Ostroverkhova (1990), 29 orders were recognized; Bey-Bienko (1966), Kimsanboyev (2002, 2006, 2017), Gorbachev (2002), and Murodov (1986) reported 34 orders; while Mavlonov (2002, 2018) recorded more than 30 orders. However, Ross (1985) indicated that the subclass Entognatha consists of three orders, and Ectognatha (insects) includes 27 orders — data that closely align with our analysis.

Currently, Hexapoda comprises two main classes: Entognatha and Insecta. Fossil specimens of Protura, Collembola, and Diplura from the class Entognatha have been discovered in Devonian, Carboniferous, and Cretaceous strata, dating back approximately 400 million years [28, 15, 16, 24]. According to Hennig (1953), Protura, Collembola, and Diplura belong to Entognatha (organisms with internal mouthparts), in contrast to Ectognatha (insects with external mouthparts). All Hexapoda members possess a three-part body structure (head, thorax, abdomen) with three pairs of legs attached to the thorax [1].

The superficial similarities among these three arthropod groups — such as small body size, living

under soil, leaf litter, or stones — and the monophyletic nature of Diplura have led to intense debates in recent years regarding their relative phylogenetic positions [6].

Following the incorporation of additional data and corrections, Luan (2005) conducted molecular analyses of rDNA genes (18S and 28S) using primers, studying nine species of Protura, nine species of Diplura, ten species of Collembola, and thirteen other arthropod species. Luan's research confirmed that Protura, Diplura, and Collembola are monophyletic with 100% confidence. Furthermore, comparative analyses with Artemia revealed that Hexapoda as a whole is also monophyletic.

According to the data shown in Figure 1, Hexapoda represents an infratype divided into two classes — Entognatha and Insecta. Luan's (2005) findings indicate that Entognatha includes three orders (Protura, Diplura, and Collembola), while Insecta is divided into three subclasses (Archeognatha, Dicondylia, and Pterygota). The subclass Pterygota is further subdivided into Paleoptera and Neoptera [17].

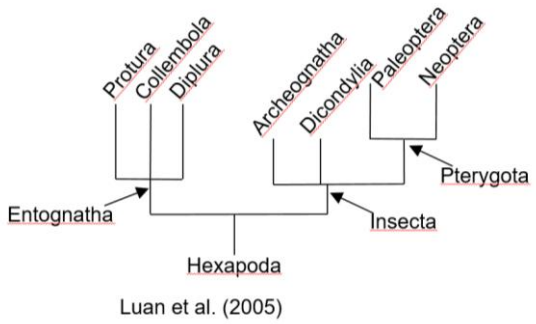

Figure 1. *Phylogenetic relationships among basal Hexapoda subclasses according to Luan (2005).*

Similarly, the order Thysanura (bristletails) has maintained its taxonomic position in recent years. Today, it continues to be recognized under the name Archaeognatha, preserving its rank within the systematic classification of insects [3].

As a result of extensive phylogenetic and evolutionary studies, one of the major orders — Odonatoptera — has retained its systematic status but is now referred to as Odonata. This order currently unites two primary suborders: Zygoptera and Epiprocta [20].

During the past century, numerous debates and studies have been conducted on the order Isoptera (termites). Although termites exhibit biological and morphological similarities to ants (Hymenoptera: Formicidae), they are not ants. Despite displaying sexual polymorphism similar to wasps (Hymenoptera: Vespidae) or bees (Hymenoptera: Apidae), they are not members of those groups either. As a resolution to these conflicting interpretations, Inward et al. (2007) reclassified termites as a group of eusocial cockroaches, which is clearly illustrated in the table below.

Set of characteristics	References	T/B?	No. roaches	T/C?
12S, 28S, 18S, COII, H3	Inward et al (2007)	Yes	6/22/65/81	Yes
16S, 12S	Kambhampati (1995)	No	4/12/24/32	No
Morphology	Thorne&Carpenter(1992)	No	Not divided into specific levels	No
Morphology	Deitz et al.(2003)	Yes (may remain as a group)	Not divided into specific levels	Yes
Oothecae	Nalepa&Lenz(2000)	Yes	Phylogeny not	Not fully

			described	studied
endog, 18S	Lo et al. (2000)	Yes	5/4/5/6	Yes
18S, 12S, 16S, COII	Lo et al. (2003)	Yes	5/4/6/9	Yes
18S, 28S, H3	Terry&Whiting (2005)	Yes	4/?/?/6	Yes
Morphology	Klass&Meier (2006)	Yes	5/13/20/21	Yes

Jadval-1. *Inward et al.ning marfologik va molecular tadqiqotlaridagi termitlar va tarakanlarning bir turkumga qo'shilish sabablari yoritilgan jadval.*

Table 1. Table illustrating the reasons for combining termites and cockroaches into a single order according to the morphological and molecular studies of Inward et al.

The table above summarizes the studies conducted by various authors and their results. Endog refers to Endoglucanase, while H3 denotes Histone 3. The column labeled T/B indicates whether termites should occupy a position within cockroaches (Blattodea), and T/C refers to whether termites should form a sister group to the genus *Cryptocercus* (Blattodea: Cryptocercidae). The final column represents the taxonomic ranks (family/subfamily/genus/species) of the groups studied (excluding termite families). These studies collectively demonstrate the research findings and evidence supporting the phylogenetic relationship between termites and cockroaches [10].

The order Mantodea has also been the subject of numerous studies, and as a result, it is currently retained as an order within the superorder Dictyoptera (which includes Blattodea and Mantodea). Another debated issue concerns why earwigs (Dermaptera) are considered part of the cockroach-like lineage (Blattopterida). This classification is based on the presence of cerci — paired appendages at the end of the abdomen — which are also found in termites, cockroaches, and earwigs. However, since members of Orthoptera also possess cerci, this feature continues to be a subject of taxonomic debate to this day [30] (Figure 2).

		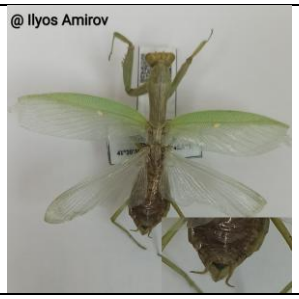	
Termite	*Shelfordella lateralis* (Walker, 1868) cereci	*Hierodula transcaucasica* Brunner von Wattenwyl, 1878 cereci	*Dericorys albidula* (Serville, 1838) cereci

Figure 2. Cerci of representatives of the superorder Dictyoptera and the order Orthoptera.

The order Hemiptera within the superorder Paraneoptera is the largest order of this group and ranks fifth among all insect orders in terms of species diversity. It has long been a subject of extensive research and scientific debate. Until around 1930, Hemiptera (true bugs) and Homoptera (equal-winged insects) were considered two separate orders based on differences in wing structure [2]. However, beginning in the 1960s, hypotheses emerged suggesting that, due to the similarity of their mouthpart structures, these two groups actually belonged to a single order. This idea was later accepted by the scientific community [9, 3, 14, 23].

Within Hemiptera, Homoptera is now treated as a suborder-like group that includes three infraorders: Sternorrhyncha, Auchenorrhyncha, and Coleorrhyncha. Studies on the mitochondrial genomes of Homoptera have confirmed their monophyletic origin [43]. Based on this, Homoptera is considered a sister group to Heteroptera, both forming part of Hemiptera and maintaining its

position as a suborder. According to the mitogenomic phylogenetic study of Cui et al. (2013), which analyzed mitochondrial genes in representatives of the order Hemiptera, both Homoptera and Auchenorrhyncha were found not to be monophyletic. The research included 27 species representing hemipteroid taxa. The results indicated that the order Hemiptera comprises two main suborders: Heteroptera and Homoptera [4].

The table below presents the current classification of insects into three subclasses. One of the principal subclasses, Pterygota (winged insects), is further divided into two groups: Paleoptera (ancient-winged insects, including Ephemeroptera — mayflies and Odonata — dragonflies) and Neoptera (modern-winged insects). From a developmental perspective, insects are divided into Holometabola and Hemimetabola based on their metamorphosis type. However, since Archaeognatha and Zygentoma lack a metamorphic stage, they are excluded from these categories.

Furthermore, the subclass Neoptera comprises four major lineages: Polyneoptera, among others. The classification of insects presented in the following table is based on the Integrated Taxonomic Information System (ITIS), updated as of September 13, 2025 [31].

Jadval-2. *ITIS tizimi asosida hasharotlar sistematikasining zamonaviy holati yoritilgan*

Sinf	Insecta						
Kenja sinf	Archaeognatha	Dicondylia	Pterygota				
Infrasinf	-	-	Palaeoptera	Neoptera			
Guruhlar	-	-	Hemimetabola			Holometabola	
Katta turkumlar	-	-	-	Polyneoptera	Paraneoptera	Neuropterida	Holometabola
Turkumlar	Archaeognatha	Zygentoma	Ephemeroptera Odonata	Blattodea Dermaptera Embioptera Grylloblattodea Mantodea Mantophasmatodea Orthoptera Phasmida Plecoptera Zoraptera	Psocodea Hemiptera Thysanoptera	Rhaphidioptera Neuroptera Megaloptera	Coleoptera Diptera Hymenoptera Lepidoptera Mecoptera Siphonaptera Strepsiptera Trichoptera

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