



# Morphological Characteristics of *Lepidocyrtus* (Entomobryidae) and *Salina* (Paronellidae) Collembola Genera from Bangladesh

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## Authors' contributions

This work was carried out in collaboration among all authors. Author MSI designed the research, collected and identified the samples, drawn image and line diagram and wrote the manuscript. Author NM collected and prepared the slides, drawn image and line diagram. Author MMH helped in manuscript preparation. Author MMH supervised the research. All authors read and approved the final manuscript.

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## ABSTRACT

The purpose of this research is to identify the collembola of the families Entomobryidae and Paronellidae. In Bangladesh, a few genera, and species of the Paronellidae and Entomobryidae families have been described and documented. The morphological traits of five genera of

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*Lepidocyrtus* and two genera of *Salina* collembola were described and illustrated in this work. Among the five genera of *Lepidocyrtus*, two genera were previously misidentified as *Podura aquatica* and *Hypogastrura armata* species. In the present article, a misidentified species is described as a *Lepidocyrtus* genus. The morphological characteristics and morphometrics of those genera and their habitat details are presented here with a microphotograph and line diagram. This study helps to explore the collembolan diversity of the Entomobryidae and Paronellidae families and to identify their genus and species levels further.

**Keywords:** Morphological characteristics; lepidocyrtus; salina; entomobryidae; paronellidae; collembola.

## 1. INTRODUCTION

Collembola commonly known as springtails, are small, terrestrial, soil-dwelling insects with a diverse range of morphologies. Their taxonomical description is heavily based on their morphological descriptions [1,2]. In the present study, taxonomical identification of the *Lepidocyrtus* and *Salina* genera was based on the size, shape, pigmentation and structure of different body parts [3]. *Lepidocyrtus* belongs to the family Entomobryidae, and this family is the most diversified [4]. *Lepidocyrtus* is a slender springtail and the second biggest genus in the Lepidocyrtinae subfamily [5], and 30 genera of *Lepidocyrtus* are described worldwide. This family's members have unique features with lengthy appendages such as antennae, legs, and furcula [6,7]. Multiciliate setae on the body, an abdominal segment IV longer than III, crenulated dens, and a tiny mucro with one or two well-developed teeth, and pigmentation distinguish Entomobryidae from other families [8,9]. *Salina* is a medium-sized genus of Paronellidae with approximately 18 described genera worldwide [10,11]. Species of this family have been diagnosed based on colour pattern, mucronal and unguicular shape, number of ungula teeth, and dorsal chaetotaxy [12]. Body scale-like setae, the eye patch is normal and appears as eight isolated black circles, each corresponding to an ocellus, and dark pigment is usually present [13]. In the present study, two collembola species (*Podura aquatica* and *Hypogastrura armata*) were misidentified previously [14] and are identified and described as *Lepidocyrtus* genus presently. The aim of this study is to investigate the morphological diversity of *Lepidocyrtus* and *Salina* genera, which will be helpful for researchers for their further survey and identification of the genus and their species.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

Collembola specimens were collected from Rajshahi University Campus area located about 4.8km from Rajshahi City. It is located at 24°22'26"N and 88°36'04"E with an altitude 23m above sea level. Rajshahi University Campus is 753acres/303 hectares in size. It is situated on the northern bank of the Padma River (Fig. 1).

### 2.2 Collection of Collembola

Collembola were collected by using the Aspirator and Berlese funnel [15,16]. In the field a white plate and aspirator were used. Soil collembola was collected by using a Berlese funnel in the laboratory.

### 2.3 Preservation and Slide Preparation

Collembola specimens were preserved in vial with 70% alcohol. Hoyer's mounting medium was used for slide-mounting of the specimens. Fluorescent microscope (OLYMPUS IX-71) was used for photographic documentation following methodology [7], and Camera Lucida (10x) was utilized to prepare line diagrams.

### 2.4 Taxonomic Identification

Springtails were described at the genera level in this report, according to key. The morphological characteristics were compared with the pictorial key, and standard key for the identification. Collembola were identified at the genera level with the help of following keys [1,12,13,17,18,19,20] and website <https://collembola.org/> [6].

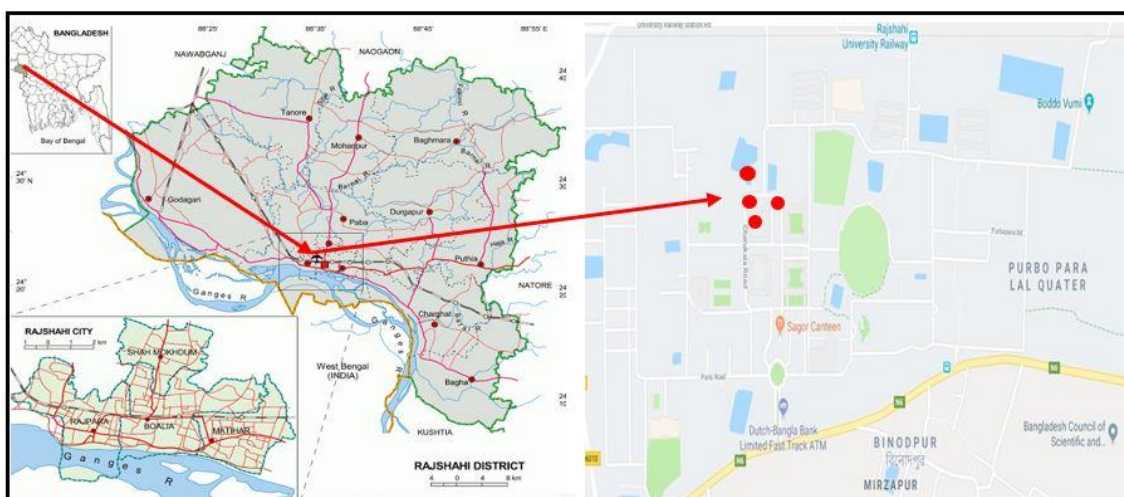


Fig. 1. The map shows the study and sampling area of Rajshahi University campus area

### 3. RESULTS AND DISCUSSION

#### 3.1 *Lepidocyrtus* (Entomobryidae)

**(A). *Lepidocyrtus* sp.:** This genus was previously misidentified as *Podura aquatica* [14]. The body colour was pinkish brown without pigmented patches or scales. First abdominal segment with a dark transverse banding pattern. Head prognathous, mouth cone-shaped, antenna rod-like-shaped. The 4<sup>th</sup> antennal segments were transparent with a pink colour. Dens crenulate and mucro bidentate. Eye pigment was present with eyes 8 + 8 on each side. The description of this genus is based on Fig. 2(a–b).

**Morphometric measurements:** Total body length was 440.61  $\mu\text{m}$  (antennae to furcula). Total antennal length is 41.83 $\mu\text{m}$ , and the first and second antennal segments were longer (11.44 $\mu\text{m}$  and 12.87 $\mu\text{m}$ ) than the third and fourth antennal segments (7.15 $\mu\text{m}$  and 10.01 $\mu\text{m}$ ). Head, thorax, and abdominal length were 34.32 $\mu\text{m}$ , 57.2 $\mu\text{m}$ , and 204.30 $\mu\text{m}$ , respectively. Manubrium was larger (57.2 $\mu\text{m}$ ) than the dentes (45.76 $\mu\text{m}$ ), and total furcula length was 102.96 $\mu\text{m}$ . Morphometric measurements were presented in Table 1. **Habitat:** This genus was found in leaf litter, soil, and open grassland.

**(B). *Lepidocyrtus* sp.:** This genus was previously misidentified as *Hypogastrura armata* [14]. The body was grey-black and marbled. Pronotum was well developed. Head obliquely prognathous. The antenna was pigmented. A thin line was present from the 2nd abdominal segment to the 5th abdominal segment. Sense

organ on the 3rd antennal segment with rods only; the 4<sup>th</sup> antennal segment was larger than the 3rd antennal segment. The furcula is obliquely reaching the ventral tube. Dentes are larger than the manubrium. Dens crenulate and mucro bidentate. Eye pigment was present with eyes 8 + 8 on each side. The description of this genus was based on Fig. 2(c–d).

**Morphometric measurements:** Total body length was 652.8  $\mu\text{m}$  (antennae to furcula). Total antennal length was 110.83 $\mu\text{m}$ , and the second and fourth antennal segments were longer (25.03 $\mu\text{m}$  and 50.05 $\mu\text{m}$ ) than the first and third antennal segments (14.3 $\mu\text{m}$  and 21.45 $\mu\text{m}$ ). Head, thorax, and abdominal length were 62.92 $\mu\text{m}$ , 107.25 $\mu\text{m}$ , and 271.7 $\mu\text{m}$ , respectively. Manubrium was larger (57.2 $\mu\text{m}$ ) than the dentes (45.76 $\mu\text{m}$ ), and total furcula length was 100.1 $\mu\text{m}$ . Morphometric measurements were shown in Table 1. **Habitat:** This genus was found in leaf litter, soil, and open grassland.

**(C). *Lepidocyrtus* sp.:** Body with distinct dark pigmented patches in a light brown colour. Abdominal segment III has a middle quadrangular dark patch, and abdominal segment V has a posterior transverse band. The first segment of the antenna is not as transparent as the others and is covered with a black circular band. Dental spines are simple; the mucro is usually much shorter than the dens, and the mucro is annulated. Dens are not crenulate, straight, and usually form a basal angle with the manubrium. Dense without dorsal scales and with an apical lobe. Eye pigment was present with eyes 8 + 8 on each side. The description of this genus was based on Fig. 2(e–f).

**Morphometric measurements:** Total body length was 826.82 µm (antennae to furcula). Total antennal length was 357.5µm, and the second and third antennal segments were longer (102.96µm and 105.82µm) than the first and fourth antennal segments (85.8µm and 62.92µm). Head, thorax, and abdominal length were 68.64µm, 74.64µm, and 160.16µm, respectively. The manubrium was larger (85.8µm) than the dentes (80.08µm), and the total furcula length was 165.88µm. Morphometric measurements were presented in Table 1. **Habitat:** This genus was found in leaf litter, soil, and open grassland.

**(D). *Lepidocyrtus* sp.:** Body colour was brownish, and the body had a markedly striking pattern. The 1<sup>st</sup> abdominal segment has a black circular band, and the 2<sup>nd</sup> abdominal segment has a transverse black band. Two broad lines run from the second to the fifth abdominal segment, and a circular black colour band was present in the in the last abdominal segment. Dentes larger than the manubrium, dentes annulated, and mucro bidentate. Eye pigment was present with eyes 8 + 8 on each side. The description of this genus was based on Fig. 2(g-h).

**Morphometric measurements:** Total body length was 803.66 µm (antennae to furcula). Total antennal length was 243.1µm, and the second and fourth antennal segments were longer (62.92µm and 91.52µm) than the first and third antennal segments (31.46µm and 57.2µm). Head, thorax, and abdominal length were 80.08µm, 85.8µm, and 188.76µm, respectively. The manubrium was smaller (91.52µm) than the dentes (114.4µm), and the total furcula length was 205.92µm. Morphometric measurements were shown in Table 1. **Habitat:** It dwells in the bushes, under the bark of dead plants, and finds other sites of human habitation.

**(E). *Lepidocyrtus* sp.:** Body is brownish in color and marked with blue. The thoracic and abdominal segments are well separated.

Antenna paddle liked shaped and pigmented with purple colored. Eyes relate to the ridge. Dentes shorter than the manubrium, and mucro bidentate and annulated. Eye pigment is present with eyes 8 + 8 on each side. All the characteristics discussed here are based on Fig. 2(F).

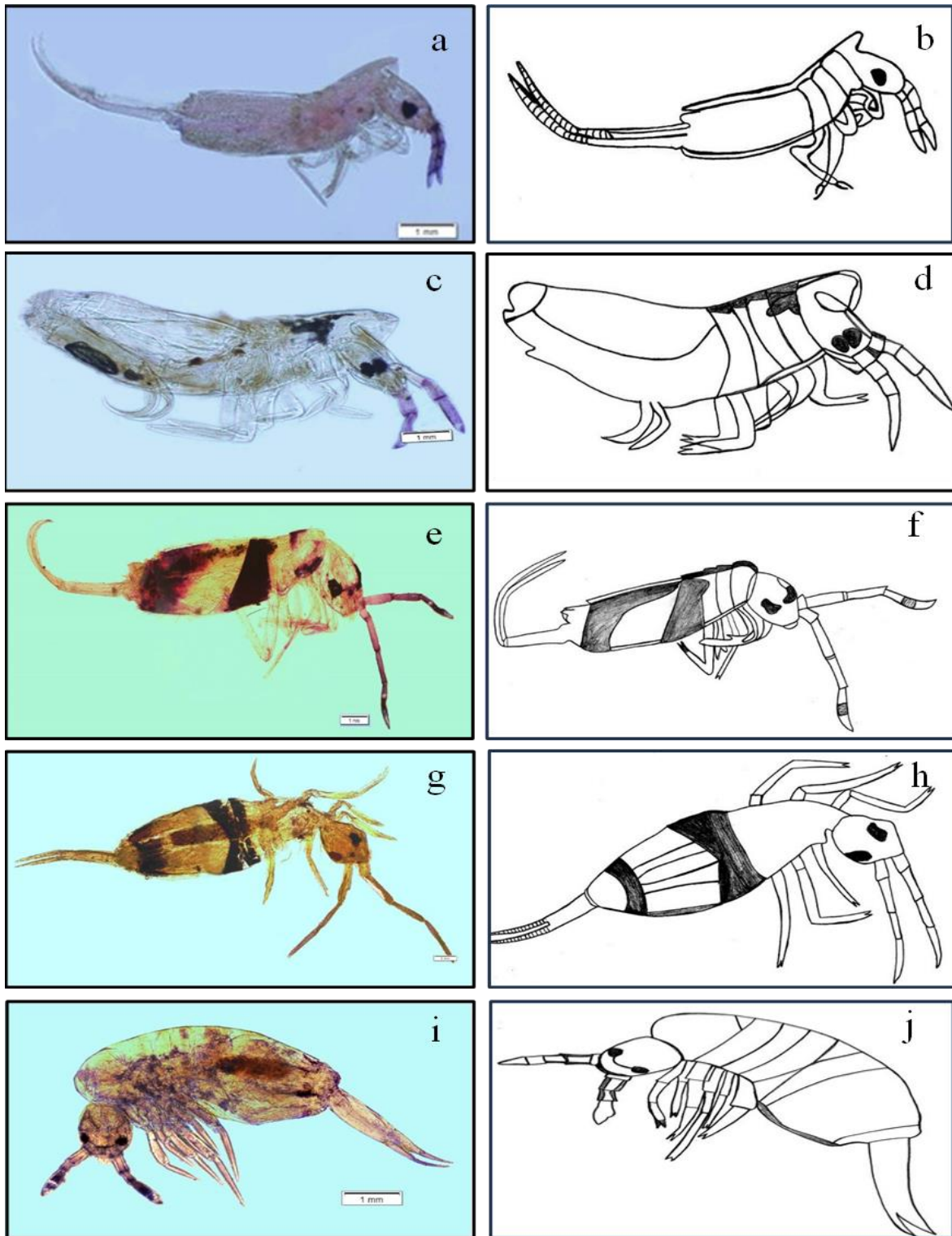
**Morphometric measurements:** Body length is 610.61µm (antennae to furcula). Total antennal length is 101.53µm, and second and fourth antennal segment is longer (22.88µm and 45.76µm) than the first and third antennal segment (17.16µm and 15.17µm). Head, thorax, and abdominal length is 62.92µm, 114.4µm, 171.6µm respectively. manubrium is larger (85.8µm) than the dentes (74.36µm), and total furcula length is 160.16µm. Morphometric measurements were shown in Table 1. **Habitat:** It dwells in the bushes, under bark of dead plants, and found other sites of human habitation.

### 3.2 *Salina* (Paronellidae)

**(A). *Salina* sp.:** Body is round-elongate, not globular type. The body color is brown with an orange patch. Anteriorly, the head capsule has a dark band that runs through the bases of the antennae and connects two ocelli. The eye patch is more conspicuous and triangle shape, and two eye patches are connected, and a spot present in the middle of connecting point. The lateral side of the thorax part is covered with deep black lines. Body scales absent. Traditionally, species have been diagnosed based on color pattern, mucronal and unguicular shape, number of ungula teeth, and dorsal chaetotaxy. This species has large antennae with four segments. In comparison to its body size, antenna is segmented and elongated. The second and third antennal segments is larger than the first and fourth antennal segment. Dentes are larger than manubrium. All the characteristics discussed here are based on Fig. 3(a-b).

**Table 1. Length (mm) of different body parts of the genera *Lepidocyrtus* sp.**

| Genera name                | Antenna length | Head length | Thorax length | Abdominal length | Furcula length | Total body length |
|----------------------------|----------------|-------------|---------------|------------------|----------------|-------------------|
| A. <i>Lepidocyrtus</i> sp. | 41.83          | 34.32       | 57.2          | 204.30           | 102.96         | 440.61            |
| B. <i>Lepidocyrtus</i> sp. | 110.83         | 62.92       | 107.25        | 271.7            | 100.1          | 652.8             |
| C. <i>Lepidocyrtus</i> sp. | 357.5          | 68.64       | 74.64         | 160.16           | 165.88         | 826.82            |
| D. <i>Lepidocyrtus</i> sp. | 243.1          | 80.08       | 85.8          | 188.76           | 205.92         | 803.66            |
| E. <i>Lepidocyrtus</i> sp. | 101.53         | 62.92       | 114.4         | 171.6            | 160.16         | 610.61            |



**Fig. 2. Microphotograph and line diagram of Entomobryidae collembola genus: a-b. Lepidocyrtus sp., c-d. Lepidocyrtus sp., e-f. Lepidocyrtus sp., g-h. Lepidocyrtus sp., i-j. Lepidocyrtus sp.**



**Morphometric measurements:** The total length of the body (antennae to furcula) is 737.98µm. The antennal length is 251.68µm. The lengths of the head, thorax, and abdomen are 80.08µm, 57.2µm, and 143.1µm, respectively. Dentes are longer (114.4µm) than manubrium (91.52µm), and the total length of the furcula is 205.92µm. Morphometric measurements were shown in Table 2. **Habitat:** This species is found in open grassland, and bushland.

**(B). *Salina* sp.:** Body color is navy blue with black patch and lines. The eye patches always extend their pigment at the end of the lateral part of the head, two longitudinal broad lines extend from from 1<sup>st</sup> thoracic segment to abdomen and another line is present throughout the abdomen. Dentes are smooth, dental spines are absent, manubrium is smaller than dentes. All the characteristics discussed here are based on Fig. 3(c-d).

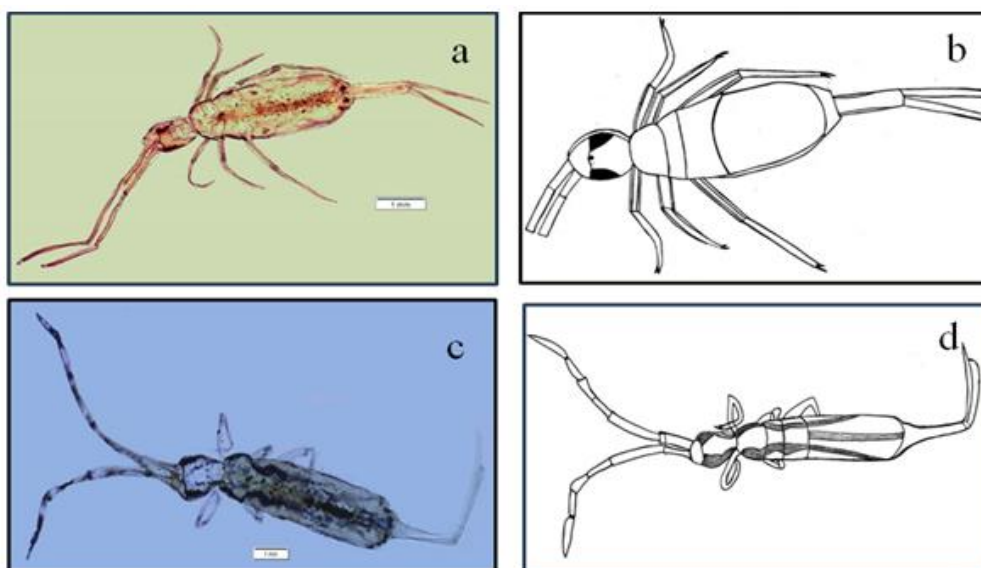
**Morphometric measurements:** The length of the body from antennae to furcula is 832.97µm. Total antennal length is 278.85µm, Head, thorax,

and abdominal length are 64.35µm, 107.25µm, and 150.15µm respectively. Dentes are longer (132.7µm) than manubrium (101.1µm), and the total length of the furcula is 232.37µm. Morphometric measurements were shown in Table 2. **Habitat:** This species is found in leaf litter and open grassland.

In the present study, *Lepidocyrtus* is distinguished by four-segmented antennae, eight eyes, and a bi-dentate mucro with a basal spine, finely ciliate scales, and a lack of dental spines and pigmentation of the body. The crenulate dentes, body scales, mucro spine, dentes scale, fourth abdominal segment size, and eye numbers are described and illustrated characteristics for *Lepidocyrtus* genus identification [1,2,6,21,22,23] which was similar with the present findings. *Salina* genera have a uniform morphology, which makes it challenging to distinguish between species. The described genus characteristics are based on presence or absence of ocelli and setae, dental spine, and mucro, den size and pigmentation of the body which is supported by identified key [12,13,24].

**Table 2. Length (mm) of different body parts of the genera *Salina* sp.**

| Genera name          | Antenna length | Head length | Thorax length | Abdominal length | Furcula length | Total body length |
|----------------------|----------------|-------------|---------------|------------------|----------------|-------------------|
| A. <i>Salina</i> sp. | 251.68         | 80.08       | 57.2          | 143.1            | 205.92         | 737.98            |
| B. <i>Salina</i> sp. | 278.85         | 64.35       | 107.25        | 150.15           | 232.37         | 832.97            |



**Fig. 3. Microphotograph and line diagram of Paronellidae collembola: a-b. *Salina* sp., c-d. *Salina* sp.**

#### 4. CONCLUSION

In our country, research interest in collembola fauna is always negligible, but this fauna has an immense role in soil fertility and soil rehabilitation. This research article provides a morphological description of ten collembola genera. It is very difficult to identify collembola species based on morphological investigation because of the complex and cryptic species patterns that exist. Along with morphological studies, molecular genomic approaches are needed for identification up to the species level.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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