A short-term investigation of diel vertical migrations of the calycophoran Siphonophora in the open south Adriatic Sea (July 2003)

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INTRODUCTION

Calycophoran siphonophores are widely-distributed colonial marine cnidarians known from all depths (PUGH, 1999). Despite their important predatory role in planktonic food webs (see PURCELL, 1997), their gelatinous consistency and fragility render them difficult to collect by conventional trawl gear; they are consequently easy to ignore (PUGH, 1984; HOSIA & BÅMSTEDT, 2008). Their tendency to break into numerous pieces often makes it particularly challeng-
ing to obtain reliable quantitative estimates of their abundance. As a result, they generally are under-represented in plankton investigations. There are, for example, relatively few studies on calycophoran diel vertical migration (Moore, 1953; Musayeva, 1976; Casanova, 1980; Pugh, 1977; 1984, 1999; Mackie et al., 1987; Laval et al., 1989; Pagès & Gili, 1991; Andersen et al., 1992; Sardou & Andersen, 1993; Maycas et al., 1999).

Diel vertical migrations (DVM) are undertaken by a wide range of zooplanktonic taxa and probably represent the biggest daily animal migration in term of biomass on earth (Hays, 2003). Of the many factors proposed to explain this behavior (e.g. hydrographic variables, feeding activities, predator avoidance, reproduction), the change in light intensity at dusk and dawn seems to be the major controlling factor (e.g. Pugh, 1984; Frank & Widder, 2002; Graham et al., 2001; Lucić et al., 2009).

The present work reports data for calycophoran siphonophores collected over 96 h during the morning, midday, evening, and night at an open-water station in the oligotrophic south Adriatic. The goal was to elucidate the species composition of migrators and their DVM behavior. Particular focus was placed on the hypothesis that calycophoran DVM is influenced considerably by hydrographic features and light intensity. During our investigation a sharp thermocline was formed at a depth of 14 m and salinity was generally high throughout the water column. This work expands on the description of medusan DVM over the same period and at the same station (Lucić et al., 2009), with the aim being to understand the importance of planktonic cnidarians in deep oligotrophic ecosystems. Detailed results of irradiance, PAR, temperature, salinity, chlorophyll, as well as micro- and mesozooplankton composition, abundance and DVM are described by Lucić et al. (2009).

MATERIAL AND METHODS

Calycophoran siphonophores were sampled at a single station (~ 1200 m depth) in the southern Adriatic Sea (41° 44’ N, 17° 52’ E) from July 22 to July 28 (Fig. 1). The sampling program was interrupted from midday 25 July to the morning of 27 July owing to inclement weather (Table 1). Nineteen sample series (152 vertical hauls) were collected with a Nansen opening-closing net (200-µm mesh, 113-cm diameter) within the following depth intervals: 0-15 (above the thermocline), 15-50, 50-100, 100-200, 200-400, 400-600, 600-800, and 800-1200 m. Five sample series were taken during the morning, four at midday, four during the evening, and six at night (Table 1).

The average hauling speed of all tows was 0.5 m s⁻¹. Samples were preserved in a 2.5% formalin-seawater solution buffered with CaCO₃. Species identification was performed with an Olympus SZX 9 stereomicroscope. Calycophoran anterior nectophores were counted from total samples and abundance was expressed according to the number of nectophores per 10 cubic meters of each species.

Two CTD probes were used to measure temperature and salinity twice daily. The Idronaut 316 probe was used to 1200 m and the SeaBird OC25 probe, equipped with a Wetlabs FLUO sensor, above 200 m. Chlorophyll concentrations were calculated from fluorescence with software provided by Seabird. The probes are
Table 1. Temporal sequence of sampling in the south Adriatic, July 2003

<table>
<thead>
<tr>
<th>Data</th>
<th>Sampling period (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 July</td>
<td>19:30-22:50</td>
</tr>
<tr>
<td>23 July</td>
<td>01:30-04:00</td>
</tr>
<tr>
<td>23 July</td>
<td>06:25-09:50</td>
</tr>
<tr>
<td>23 July</td>
<td>11:30-15:00</td>
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<tr>
<td>23 July</td>
<td>16:00-18:40</td>
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<tr>
<td>23 July</td>
<td>21:25-23:30</td>
</tr>
<tr>
<td>24 July</td>
<td>00:25-03:45</td>
</tr>
<tr>
<td>24 July</td>
<td>06:00-09:00</td>
</tr>
<tr>
<td>24 July</td>
<td>11:35-13:45</td>
</tr>
<tr>
<td>24 July</td>
<td>17:30-20:30</td>
</tr>
<tr>
<td>25 July</td>
<td>00:15-03:45</td>
</tr>
<tr>
<td>25 July</td>
<td>06:00-09:00</td>
</tr>
<tr>
<td>27 July</td>
<td>23:45-03:05</td>
</tr>
<tr>
<td>27 July</td>
<td>05:55-09:00</td>
</tr>
<tr>
<td>27 July</td>
<td>11:45-15:00</td>
</tr>
<tr>
<td>27 July</td>
<td>17:30-20:30</td>
</tr>
<tr>
<td>28 July</td>
<td>00:00-03:10</td>
</tr>
<tr>
<td>28 July</td>
<td>05:50-08:45</td>
</tr>
<tr>
<td>28 July</td>
<td>13:00-16:15</td>
</tr>
</tbody>
</table>

accurate to 0.01 °C, 0.003 salinity units, and 0.5 m depth.

Light was measured daily to 90 m at 0600, 1200, and 1800 (local time) with a profiling radiometer (PRR800 Biospherical Instruments Inc.) at 14 wavelengths (340 – 710 nm) in addition to measurements of PAR (Photosynthetic Available Radiation) attenuation (400-700 nm). Assuming the same water properties in deep waters as in the euphotic layer, the log-line for PAR was extrapolated, prolonging the PAR attenuation profile with the same slope until 1200 m.

Representative calycophoran species within a depth layer were determined according to their frequency of occurrence (percentage) and relative abundance in all samples. The weighted mean depth (WMD) of all representative species was calculated as:

\[
WMD = \frac{\sum (n_i z_i d_i)}{\sum (n_i z_i)}
\]

where \(d_i\) is the midpoint of the depth interval of sample i, \(z_i\) is the thickness of the stratum, and \(n_i\) is the number of individuals within each depth layer (10 m⁻³).

RESULTS

Vertical distribution and DVM of the most frequent and abundant calycophores

Of the twenty calycophoran species collected, the most frequent and abundant were *Eudoxoids spiralis* and *Lensia subtilis* (Table 2). Among the less numerous, though frequently occurring, species were *Lensia meteori* and *Lensia conoidea*, followed by *Sphaeronectes koellikeri*, *Sphaeronectes irregularis*, *Lensia fowleri* and *Kephyes ovata*.

Table 2. Average abundance (No. ind. 10 m⁻³) of calycophoran siphonophores collected in the southern Adriatic Sea, July 2003

<table>
<thead>
<tr>
<th>Species/death layer</th>
<th>0-15 m</th>
<th>15-50 m</th>
<th>50-100 m</th>
<th>100-200 m</th>
<th>200-400 m</th>
<th>400-600 m</th>
<th>600-800 m</th>
<th>800-1200 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hippopodus hippopus</td>
<td>0.04±0.19</td>
<td>0.12±0.30</td>
<td>0.04±0.13</td>
<td>0.03±0.14</td>
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<td></td>
</tr>
<tr>
<td>Vogtia pentacantha</td>
<td>&lt;0.01±0.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salucelolaria turgida</td>
<td>0.13±0.40</td>
<td>0.06±0.17</td>
<td>0.04±0.18</td>
<td>0.02±0.09</td>
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<td></td>
<td></td>
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<tr>
<td>Salucelolaria chuni</td>
<td></td>
<td></td>
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<tr>
<td>Lensia conoidea</td>
<td>0.06±0.19</td>
<td>0.43±0.48</td>
<td>0.58±0.37</td>
<td>0.88±0.56</td>
<td>0.9±0.32</td>
<td></td>
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<tr>
<td>Lensia multicristata</td>
<td>0.01±0.16</td>
<td>0.01±0.19</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Lensia fowleri</td>
<td>0.23±0.32</td>
<td>0.35±0.49</td>
<td>0.07±0.14</td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>Lensia subtilis</td>
<td>0.33±0.83</td>
<td>0.32±0.24</td>
<td>4.69±3.33</td>
<td>0.39±0.78</td>
<td>0.01±0.04</td>
<td>&lt;0.01±0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lensia campanella</td>
<td>0.04±0.19</td>
<td>0.01±0.04</td>
<td></td>
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</tr>
<tr>
<td>Lensia meteori</td>
<td>7.86±5.84</td>
<td>1.54±1.53</td>
<td>0.41±0.77</td>
<td>0.05±0.08</td>
<td>0.01±0.02</td>
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</tr>
<tr>
<td>Lensia subtiloides</td>
<td>0.05±0.22</td>
<td>0.04±0.18</td>
<td>&lt;0.01±0.92</td>
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<tr>
<td>Muggiaea kochi</td>
<td>0.05±0.09</td>
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</tr>
<tr>
<td>Chelophyes appendiculata</td>
<td>0.30±0.62</td>
<td>2.33±4.01</td>
<td>3.49±2.90</td>
<td>1.58±2.30</td>
<td>0.06±0.23</td>
<td>0.01±0.03</td>
<td>0.02±0.04</td>
<td>0.01±0.02</td>
</tr>
<tr>
<td>Eudoxoids spiralis</td>
<td>0.90±1.32</td>
<td>1.21±1.32</td>
<td>3.17±6.73</td>
<td>0.19±0.37</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Sphaeronectes koellikeri</td>
<td>0.47±0.87</td>
<td>2.32±1.96</td>
<td>0.99±1.55</td>
<td>0.23±0.43</td>
<td>0.01±0.02</td>
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<td></td>
</tr>
<tr>
<td>Sphaeronectes irregularis</td>
<td>0.03±0.14</td>
<td>0.02±0.06</td>
<td>0.03±0.07</td>
<td>0.03±0.12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sphaeronectes fragilis</td>
<td>0.04±0.08</td>
<td>0.26±0.28</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kephyes ovata</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abylopsis tetragona</td>
<td>0.01±0.05</td>
<td>0.01±0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bassia bassensis</td>
<td>0.01±0.05</td>
<td>0.02±0.35</td>
<td>0.10±0.32</td>
<td>0.07±0.23</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
*Eudoxoides spiralis* was found in all depth layers, with higher values below the thermocline to 200 m depth (Fig. 2). Daily WMD data show the bulk of the population between 68 and 134 m (Table 3). Slight and irregular migrations toward upper layers were noted in the evening and at night, during which some specimens were found above the thermocline. The maximum abundance was 18 nectophores 10 m$^{-3}$.

*Lensia subtilis* was found from the surface down to 600 m, with the higher values below the thermocline to 100 m depth (Fig. 3). The maximum abundance was 13 nectophores 10 m$^{-3}$. Daily WMD data showed that most of the population varied from 43 to 82 m (Table 3). A slight movement toward the surface was noted in the evening, and migrations in both directions were commonly observed during the night.

**Fig. 2.** Diel vertical migration of *Eudoxoides spiralis* in the southern Adriatic Sea, July 2003. Each unit between ticks along the x-axis represents 10 nectophores per 10 m$^3$, and the arrows represent sampling dates.

**Fig. 3.** Diel vertical migration of *Lensia subtilis* in the southern Adriatic Sea, July 2003. Each unit between ticks along the x-axis represents 13 nectophores per 10 m$^3$, and the arrows represent sampling dates.
Table 3  The weighted mean depth (WMD) and sampling depth ranges (SDR) of most common calycophoran siphonophores calculated from data obtained at different day time and from all data collected in the southern Adriatic Sea, July 2003.

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Morning WMD</th>
<th>SDR</th>
<th>Midday WMD</th>
<th>SDR</th>
<th>Evening WMD</th>
<th>SDR</th>
<th>Night WMD</th>
<th>SDR</th>
<th>All data WMD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lensia conoidea</strong></td>
<td>642</td>
<td>200-1200</td>
<td>739</td>
<td>200-1200</td>
<td>651</td>
<td>200-1200</td>
<td>691</td>
<td>100-1200</td>
<td>677</td>
</tr>
<tr>
<td><strong>Lensia fowleri</strong></td>
<td>346</td>
<td>100-600</td>
<td>198</td>
<td>100-400</td>
<td>276</td>
<td>100-600</td>
<td>303</td>
<td>100-600</td>
<td>289</td>
</tr>
<tr>
<td><strong>Lensia meteori</strong></td>
<td>224</td>
<td>100-800</td>
<td>178</td>
<td>100-800</td>
<td>247</td>
<td>100-800</td>
<td>224</td>
<td>100-1200</td>
<td>219</td>
</tr>
<tr>
<td><strong>Lensia subtilis</strong></td>
<td>66</td>
<td>0-200</td>
<td>70</td>
<td>15-200</td>
<td>43</td>
<td>15-200</td>
<td>82</td>
<td>0-600</td>
<td>67</td>
</tr>
<tr>
<td><strong>Eudoxoides spiralis</strong></td>
<td>133</td>
<td>0-1200</td>
<td>134</td>
<td>15-600</td>
<td>68</td>
<td>15-600</td>
<td>84</td>
<td>0-1200</td>
<td>110</td>
</tr>
<tr>
<td><strong>Sphaeronectes koellikeri</strong></td>
<td>65</td>
<td>0-200</td>
<td>74</td>
<td>15-200</td>
<td>61</td>
<td>0-200</td>
<td>36</td>
<td>0-200</td>
<td>68</td>
</tr>
<tr>
<td><strong>Sphaeronectes irregularis</strong></td>
<td>179</td>
<td>15-600</td>
<td>120</td>
<td>15-400</td>
<td>109</td>
<td>15-400</td>
<td>127</td>
<td>0-400</td>
<td>138</td>
</tr>
<tr>
<td><strong>Kephyes ovata</strong></td>
<td>970</td>
<td>800-1200</td>
<td>1000</td>
<td>1000-1200</td>
<td>981</td>
<td>800-1200</td>
<td>1000</td>
<td>800-1200</td>
<td>983</td>
</tr>
</tbody>
</table>

Specimens were found above the thermocline in only three samples, and never at midday. **Lensia meteori** was found from 100 m depth to the bottom. Daily WMD data show that it was the most common between 178 and 297 m (Table 3), but higher values usually were in the 100 - 200 m layer (Fig. 4). Maximum abundance was 27 nectophores 10 m$^{-3}$. Sinking below 600 m was frequent, especially at night when specimens were collected near the bottom.

Daily WMD data for **Lensia conoidea** showed that most of the population occupied a depth of about 650 m (Table 3). During the day, the bulk of the population was deeper (737 m). Specimens were rarely found above 200 m, and these only during the evening and at night (Fig. 5). The maximum, two nectophores 10 m$^{-3}$, was found during the morning of July 24.

![Fig. 4. Diel vertical migration of Lensia meteori in the southern Adriatic Sea, July 2003. Each unit between ticks along the x-axis represents 13 nectophores per 10 m3, and the arrows represent sampling dates.](image)
Most of the _Sphaeronectes koellikeri_ calycophorans were found above 100 m (Fig. 6). Daily WMD data show that they were common between 36 and 74 m (Table 3). During midday, this species often aggregated in the 50 - 100 m layer. The highest values of 17 and 26 nectophores 10 m$^{-3}$ were found on July 23 and July 27, respectively.

The calycophoran _Sphaeronectes irregularis_ occupied the layer from 15 to 600 m. The
maximum abundance was 7 nectophores 10 m$^{-3}$. The DVM of this species was irregular and independent of daily light patterns. WMD data show that it was most commonly found between 109 and 179 m (Table 3).

According to the WMD calculations, the greatest DVM was noted for the species *Lensia fowleri* (148 m). Daily WMD data suggest an atypical vertical distribution of this species: It migrates to the upper layer by midday (198 m) and descends at night, with the deepest penetration of 346 m reached in the morning (Table 3). The maximum abundance of two nectophores 10 m$^{-3}$ was in the 200-400 m layer at night on July 28 (Fig. 7).

Daily WMD data for the calycophoran *Kephyes ovata* showed that most of the population permanently resided below 800 m (Table 3) and rarely migrated to the upper layer. The maximum abundance was one nectophore 10 m$^{-3}$.

**Relationships between calycophoran siphonophores and environmental factors**

*Muggiaea kochi* was found exclusively above the thermocline. The thermocline was not
a barrier for most surface species: *Hippopodius hippopus*, *Sulculeolaria chuni*, *Lensia subtilis*, *Eudoxoides spiralis*, *Sphaeronectes koellikeri*, *Abylopsis tetragena* and *Bassia bassenensis*. These species were found at least once above the thermocline, mainly in samples collected during the morning and at night.

There was a change in the slope of the relationship between the logarithm of light intensity and depth for PAR. Lines between the surface and 40 m depth values show similar slopes for the different daily light regimes, but from 40-90 m the slope is somewhat higher for the morning/evening values. Extrapolation to conditions at 1200 m depth was based on changes in light intensity below 40 m depth to the lowest measured layer. The two lines define the daily intensity range at the particular depth (Figs. 8 and 9).

The vertical distributions of calycophorans nectophores suggest clear species-specific differences for preferred light intensities. The WMD position of common species (Table 3) along extrapolated PAR curves (Fig. 8 and 9) illustrates a range of preference for different light intensities during the daily incidence maximum: *Lensia subtilis* (10⁻⁸ to 0.05511), *Sphaeronectes koellikeri* (10⁻⁸ to 0.05516), *Eudoxoides spiralis* (10⁻¹⁷ to 10⁻¹⁰), *Lensia fowleri* (10⁻²⁰ to 0.0005), *Lensia meteori* (10⁻²⁵ to 0.0005), *Lensia conoidea* (10⁻³⁷ to 10⁻⁶) and *Kephyes ovata* (10⁻³⁷ to 10⁻²⁵). *Sphaeronectes irregularis* was present from 10⁻²⁰ to 0.05516, but its DVM was independent of the daily light pattern and was not included in Fig. 8 and 9.

**DISCUSSION**

Of the 24 calycophore species known for the Adriatic Sea (GAMULIN & KRŠINIĆ, 2000), twenty were found during this study. In general, species composition did not differ considerably from previous investigations of the deep southern Adriatic (GAMULIN & KRŠINIĆ, 1993; BATISTIĆ et al., 2004; LUČIĆ et al., 2005). The cyclonic gyre, which is well-established in this region (GAČIĆ et al., 2002), is probably responsible for maintaining a relatively constant composition of the plankton community, including gelatinous taxa. The rather stable environmental conditions over the study period suggest that a coherent system was sampled (MOROVIĆ et al., 2006; LUČIĆ et al., 2009).

Total nectophore densities, less than those noted in spring 2002 (see LUČIĆ et al., 2005), are still among the highest reported for the open sea (PARTITI, 1964; PUGH, 1984; GILI & PAGÈS, 1987; GILI et al., 1988; PAGÈS & GILLI, 1991; ANDERSEN et al., 1992; CARRÉ & CARRÉ, 1993; LO & BIGGS, 1996; BUECHER, 1999; GAMULIN & KRŠINIĆ, 1993; GASCA, 1999; THIBAUT-BothA et al., 2004; PALMA & SILVA, 2006; HOSIA & BÅMSTEDT, 2008). Our results affirm that *Eudoxoides spiralis* and *Lensia subtilis* are the most numerous species in the open south Adriatic, where they represent a considerable fraction of the total abundance of gelatinous zooplankton.

The high predation rate of siphonophores on zooplankton plays an important role in the pelagic food web (PURCELL, 1981, 1982, 1997; PURCELL & KREMER, 1983; MILLS, 1995; PUGH, 1999) and may contribute to defining trophic
structure (PAGÈS et al., 2001). Most calycophores have small gastrozooids and consume only small zooplankton (PURCELL, 1981). Production and maturation of some species correlate with prey availability (PURCELL, 1982; SILGUERO & ROBINSON, 2000). Above 200 m, high calycophoran abundance coincides with the highest density of copepods and their developmental stages (see LUČIĆ et al., 2009). Though less numerous, calycophoran fauna is usually well established in the mesopelagic and is linked nutritionally with the deep-sea micro- and mesozooplankton that permanently inhabit the southern Adriatic (KRŠINIĆ, 1998; KRŠINIĆ & GRBEC, 2002; LUČIĆ et al., 2009).

The first investigation of diel differences in calycophoran bathymetric distribution in the southern Adriatic (LUČIĆ et al., 2005) indicated a dependence of some species on daily light intensity changes. The present data support this observation and, owing to the finer scale of temporal sampling, offer additional details of calycophoran diel vertical patterns.

The most common calycophors exhibited substantial variations of depth range: Eudoxoides spiralis (0-1200), Lensia conoidea (100-1200), L. meteori (100-1200), L. subtilis (0-600), Sphaeronectes irregularis (0-600), L. fowleri (100-600), Kephyes ovata (800-1200) and S. koellikeri (0-200). WMD calculations showed that these species do not perform extensive DVM, as noted for medusae (LUČIĆ et al., 2009). Thus, the bulk of the population for a defined species usually inhabited layers characterized by the preference for light of a particular intensity.

The deep species Kephyes ovata, previously known as Clausophyces ovata and reclassified by PUGH (2006), is primarily non-migratory. Typical nocturnal movements to the surface layers were recorded for Lensia conoidea and Sphaeronectes koellikeri, previously known as Sphaeronectes gracilis and reclassified by PUGH (2009). Lensia subtilis and Eudoxoides spiralis migrated toward the surface during the evening. During the night they sank deeper.

Lensia meteori and L. fowleri reached upper layers at midday. Such behaviour could be explained by foraging strategies, which vary among planktonic cnidarians (PURCELL, 1981, 1982, 1997; MILLS, 1995), or by avoidance of predators and competitors. For example, the midday WMD of L. meteori and L. fowleri calculation coincided with the upper borderline of the vertical distribution of narcomedusa Solmissus albescens (LUČIĆ et al., 2009) which is known to feed on other gelatinous animals (RASKOFF, 2002).

The DVM of Sphaeronectes irregularis was irregular and independent of diel light patterns. This is contrary to the results of LUČIĆ et al. (2005) when, in spring, this species was regularly found in upper layers. The finer scale of temporal sampling (6-h intervals) in the current study certainly permits more detailed insight into this calycophoran DVM. However, it should be kept in mind that the higher summer temperatures of the upper layers can also be expected to influence the diel vertical pattern of this species.

Of other frequent and abundant calycophors, Lensia subtilis and Sphaeronectes koellikeri were rarely found above the thermocline and never at midday.

The vertical distribution of some less abundant calycophores, i.e. Hippopodius hippopus, Sulculeolaria chuni, Abylopsis tetragona and Bassia bassenensis, seemed unaffected by temperature stratification. Mugiaea kochi was only found above the thermocline. PAGÈS & GILI (1991) noted that the thermocline probably acted as a boundary for the calycophoran DVM at an offshore station off the northern coast of Namibia. At dusk, however, the urge to feed was sufficiently strong for individuals to breach this boundary and enter the surface layer.

Some calycophoran species are adapted exclusively to the lower temperatures typical of deep water throughout the year. The higher temperatures found in surface layers during the summer thus represent an effective physiological barrier for these species. The mesopelagic species Lensia meteori, L. conoidea, and L. fowleri that could be found in upper layers at night (ALVARIÑO, 1971; PUGH, 1974, 1984; ANDERSEN et al., 1992; GAMULIN & KRŠINIĆ, 2000) were noted only below 100 m during this study. Some of these species are also epipelagic at high latitudes and mesopelagic at low latitudes (PUGH, 1977; MACKIE et al., 1987; HOSIA et al., 2008).
between calycophoran DVM and controlling environmental variables, such as temperature and light intensity. Thus, certain species could be represented as key species of planktonic cnidarian assemblages found within a certain depth range. Though not homogenous, and while some undertake nocturnal migrations in both directions, all are interrelated by preferences of bathymetric distribution and specific DVM behavior. These patterns are important for understanding the role of planktonic cnidarians in the marine ecosystem.

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**Kratkoročno istraživanje dnevnih vertikalnih migracija kalikofora (Siphonophora) u otvorenimvodama južnog Jadrana (srpanj 2003.)**

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**SAŽETAK**

Istraživanje dnevne vertikalne migracije (DVM) kalikofora obavljeno je na jednoj postaji u oligotrofnom južnom Jadranu neprekidnim uzimanjem uzoraka unutar 8 dubinskih slojeva tijekom jutra, sredine dana, popodneva i noći. Od 20 zabilježenih vrsta kalikofora, glavnina obitava unutar slojeva karakteristične temperature i dnevnog intenziteta svjetlosti, a migriraju noću. Duboka vrsta Kephyes ovata nije migratorna. Tipične noćne migracije prema gornjim slojevima su zabilježene za vrste Lensia conoidea i Sphaeronectes koellikeri. Sifonofore Lensia subtilis i Eudoxoides spiralis migriraju prema površini u večernjim satima, a noću tonu dublje, dok su Lensia meteori i Lensia fowleri nađene u višim slojevima tijekom sredine dana. DVM vrste Sphaeronectes irregularis bile su nepravilne i neovisne o dnevnoj promjeni intenziteta svjetlosti. Manji broj vrsta kalikofora nađen je tijekom noći iznad sloja termokline, a za mezopelagične vrste, 100 m dubine bila je gornja migratorna granica. Stoga, kalikofore mogu predstavljati ključne vrste zajednice planktonskih žarnjaka unutar pojedinih dubinskih raspona. Premda nisu homogene i neke vrste obavljaju migracije u oba smjera, povezane su s preferiranjem određene dubinske raspadjele i specifičnim dnevnim vertikalnim migracijama.

**Ključne riječi:** žarnjaci, PAR, želatinozni plankton, vertikalna raspadjela, Sredozemno more