Reconstruct data

In [1]:
```
import pandas as pd
import numpy as np
import pygplates as pygp
from pmagpy import ipmag, pmag

import matplotlib.pyplot as plt
import cartopy
import cartopy.crs as crs
import seaborn as sns

pd.set_option('display.max_columns', None)
```

Import rotation model and continental polygons (if needed)

In [2]:
```
rotation_model = 'data/example_rotfile.rot'
static_polygons = pygp.FeatureCollection('data/example_polygons.gpml')
```

Import data

In [3]:
```
fname = 'data/Liz_Data.xlsx'
bugs = pd.read_excel(fname, engine='openpyxl')
```

Have a look at the data...

In [4]:
```
bugs.head()
```

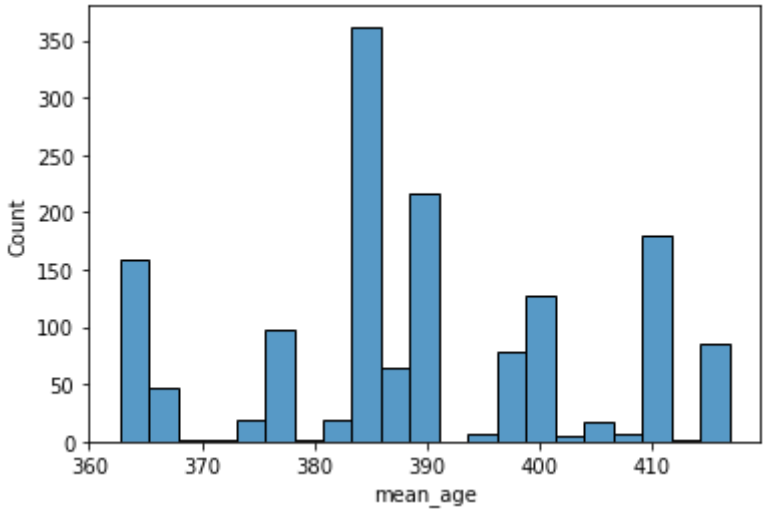
Out[4]:

	accepted_name	max_ma	min_ma	ref_author	ref_pubyr	phylum	class	order	fam
0	Neocalmonia quadricosta	383.7	382.4	Morzadec	2002	Arthropoda	Trilobita	Phacopida	Acastic
1	Radiopyge heratensis	387.7	372.2	Farsan	1981	Arthropoda	Trilobita	Phacopida	Acastic
2	Radiopyge heratensis	382.7	372.2	Farsan	1981	Arthropoda	Trilobita	Phacopida	Acastic
3	Radiopyge heratensis	382.7	372.2	Farsan	1981	Arthropoda	Trilobita	Phacopida	Acastic
4	Radiopyge heratensis	382.7	372.2	Farsan	1981	Arthropoda	Trilobita	Phacopida	Acastic

In [5]:
```
bugs['mean_age'] = bugs.apply(lambda row: (row.max_ma + row.min_ma)/2, axis=1)
```

In [6]:
```
sns.histplot(data = bugs, x = 'mean_age')
```

Out[6]:
```
<AxesSubplot:xlabel='mean_age', ylabel='Count'>
```



Set age range and filter data accordingly

In [7]:
```
time = 390
age_window = 10

tmin = time-age_window
tmax = time+age_window

tbugs = bugs.loc[((tmin <= bugs['min_ma']) & (bugs['min_ma'] <= tmax)) | ((bugs['min
```

In [8]:
```
tbugs.head(15)
```

Out[8]:

	accepted_name	max_ma	min_ma	ref_author	ref_pubyr	phylum	class	order
0	Neocalmonia quadricosta	383.7	382.4	Morzadec	2002	Arthropoda	Trilobita	Phacopida
1	Radiopyge heratensis	387.7	372.2	Farsan	1981	Arthropoda	Trilobita	Phacopida
2	Radiopyge heratensis	382.7	372.2	Farsan	1981	Arthropoda	Trilobita	Phacopida
3	Radiopyge heratensis	382.7	372.2	Farsan	1981	Arthropoda	Trilobita	Phacopida
4	Radiopyge heratensis	382.7	372.2	Farsan	1981	Arthropoda	Trilobita	Phacopida

	accepted_name	max_ma	min_ma	ref_author	ref_pubyr	phylum	class	order
5	Radiopyge heratensis	382.7	372.2	Farsan	1981	Arthropoda	Trilobita	Phacopida
51	Gondwanaspis dracula	382.7	372.2	Feist and McNamara	2007	Arthropoda	Trilobita	Odontopleurida
52	Gondwanaspis dracula	382.7	372.2	Feist and McNamara	2007	Arthropoda	Trilobita	Odontopleurida
53	Gondwanaspis spinosa	382.7	372.2	Feist and McNamara	2007	Arthropoda	Trilobita	Odontopleurida
101	Proetus (Devonoproetus) sparsinodosus	393.3	387.7	Feist and Talent	2000	Arthropoda	Trilobita	Proetida
102	Phacops (Phacops) brocki	387.7	382.7	Feist and Talent	2000	Arthropoda	Trilobita	Phacopida
103	Phacops (Phacops) brocki	388.1	383.7	Feist and Talent	2000	Arthropoda	Trilobita	Phacopida
104	Phacops (Phacops) brocki	387.7	382.7	Feist and Talent	2000	Arthropoda	Trilobita	Phacopida
216	Acanthopyge (Lobopyge) campbelli	409.1	388.1	Chatterton and Wright	1986	Arthropoda	Trilobita	Lichida
217	Crotalocephalus struszi	409.1	388.1	Chatterton and Wright	1986	Arthropoda	Trilobita	Proetida

Convert to GPlates feature format

In [9]:
```
point_features = []
for idx, row in tbugs.iterrows():
    point = pygp.PointOnSphere(tbugs.lat[idx], tbugs.lng[idx])
    point_feature = pygp.Feature()
    point_feature.set_geometry(point)
    point_feature.set_valid_time(tmax, tmin)
    point_features.append(point_feature)
```

Get plate IDs

In [10]:
```
assigned_point_features = pygp.partition_into_plates(
    static_polygons,
    rotation_model,
    point_features,
    properties_to_copy = [pygp.PartitionProperty.reconstruction_plate_id])
```

Reconstruct

In [11]:
```
reconstruction_time = time
reconstructed_point_features = []
reconstructed_static_polygons = []
pygp.reconstruct(assigned_point_features, rotation_model, reconstructed_point_featur
pygp.reconstruct(static_polygons, rotation_model, reconstructed_static_polygons, rec
```

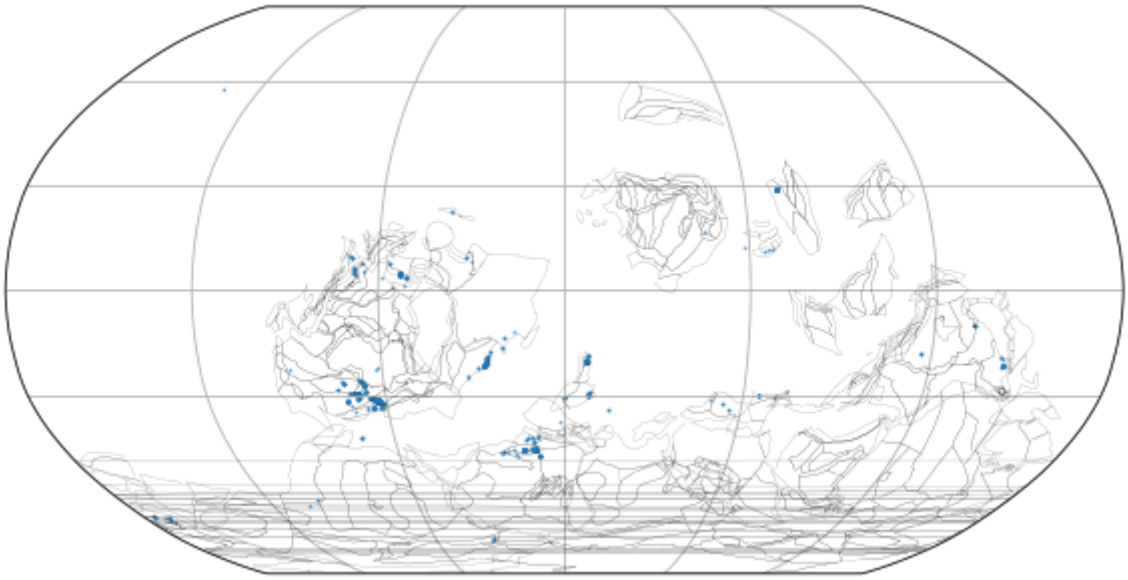
Extract data

In [12]:
```
recon_lats, recon_lons = [], []
for reconstructed_feature in reconstructed_point_features:
    recon_lats.append(reconstructed_feature.get_reconstructed_geometry().to_lat_lon(
    recon_lons.append(reconstructed_feature.get_reconstructed_geometry().to_lat_lon(

recon_poly_lats, recon_poly_lons = [], []
for reconstructed_feature in reconstructed_static_polygons:
    recon_poly = reconstructed_feature.get_reconstructed_geometry().to_lat_lon_array
    recon_poly_lats.append([i[0] for i in recon_poly])
    recon_poly_lons.append([i[1] for i in recon_poly])
```

Plot

In [13]:
```
fig = plt.figure(figsize=(10,8))
ax = fig.add_subplot(1,1,1, projection=crs.Robinson())
ax.set_global()
ax.gridlines()

#can plot coastlines, etc. here...
for i in range(len(recon_poly_lats)):
    plt.plot(recon_poly_lons[i], recon_poly_lats[i], transform=crs.PlateCarree(), co
plt.scatter(recon_lons, recon_lats, s=1, alpha=0.5, transform=crs.PlateCarree())
```

Out[13]:
```
<matplotlib.collections.PathCollection at 0x24f90897490>
```



In [14]:
```
tbugs['rlng'] = recon_lons
tbugs['rlat'] = recon_lats
```

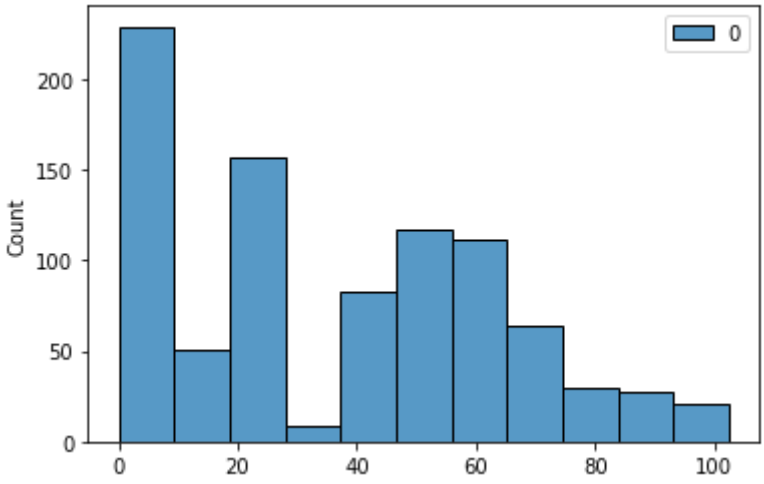
In [15]:
```
fams = tbugs.groupby('family')
```

```
fams.groups.keys()
```

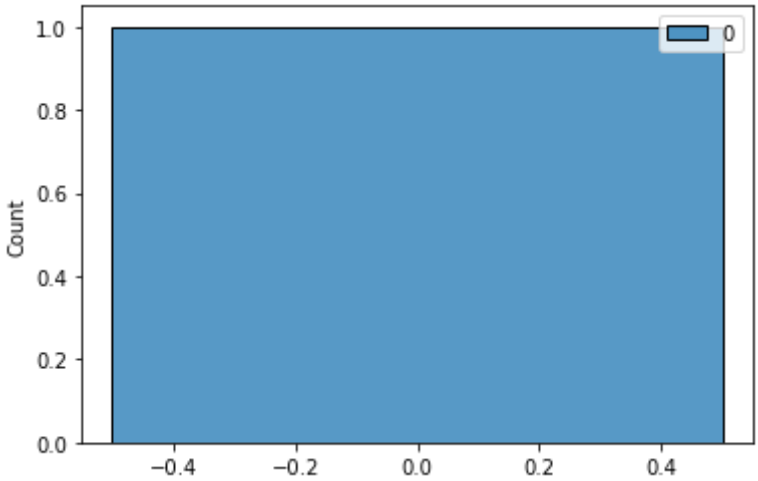
Out[15]:
```
dict_keys(['Acastidae', 'Aulacopleuridae', 'Calmoniidae', 'Calymenidae', 'Cheirurida
e', 'Dalmanitidae', 'Harpetidae', 'Homalonotidae', 'Lichidae', 'NO_FAMILY_SPECIFIE
D', 'Odontopleuridae', 'Otarionidae', 'Phacopidae', 'Phillipsiidae', 'Proetidae', 'R
orringtoniidae', 'Scharyiidae', 'Styginidae', 'Tropidocoryphidae'])
```

In [39]:
```
for fam_name, df_fam in fams:
    print (fam_name)
    print (df_fam.shape[0])

    rlats = df_fam['rlat'].to_list()
    rlons = df_fam['rlng'].to_list()
    rlonlats = np.array(list(zip(rlons, rlats)))

    if len(rlonlats) > 1:
        dm = []
        for i in range(len(rlonlats)):
            for j in range(i+1, len(rlonlats)):
                dm.append(pmag.angle(rlonlats[i], rlonlats[j]))

        dm = np.array(dm)
        sns.histplot(dm)
        plt.show()
```

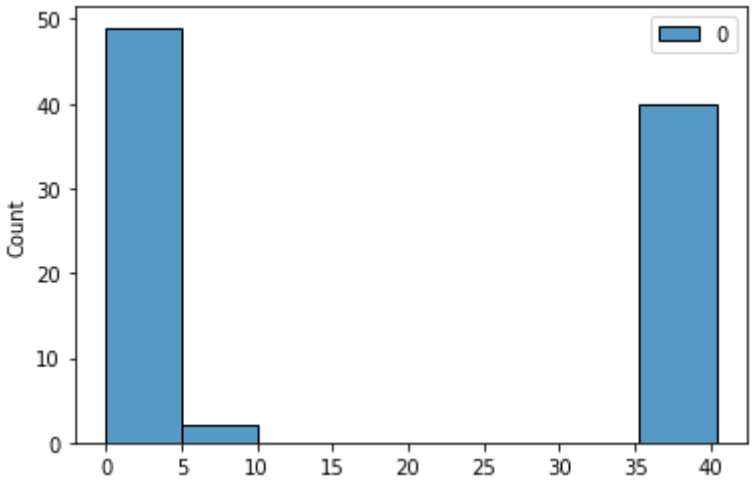
```
Acastidae
43
```



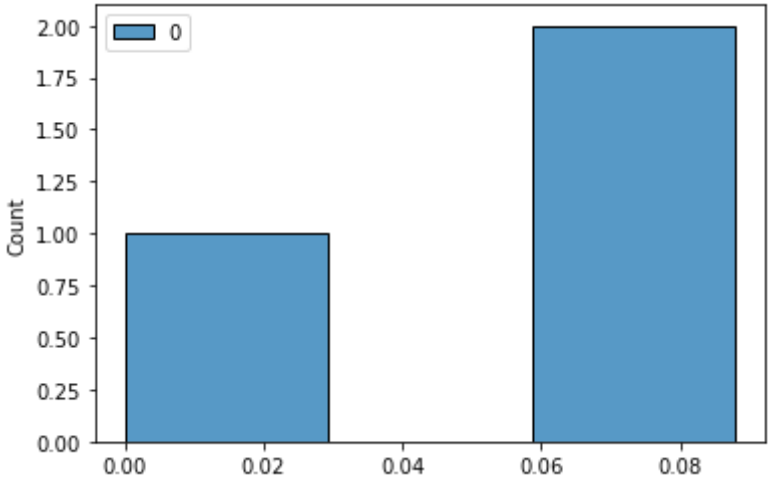

```
Aulacopleuridae
2
```



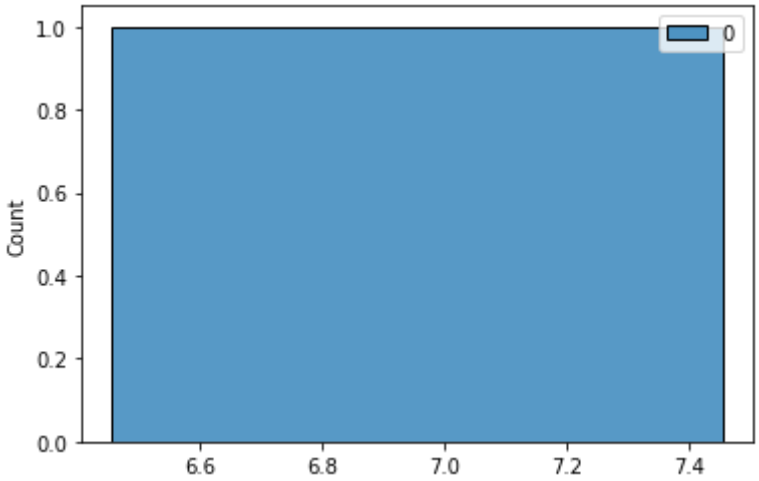

```
Calmoniidae
14
```



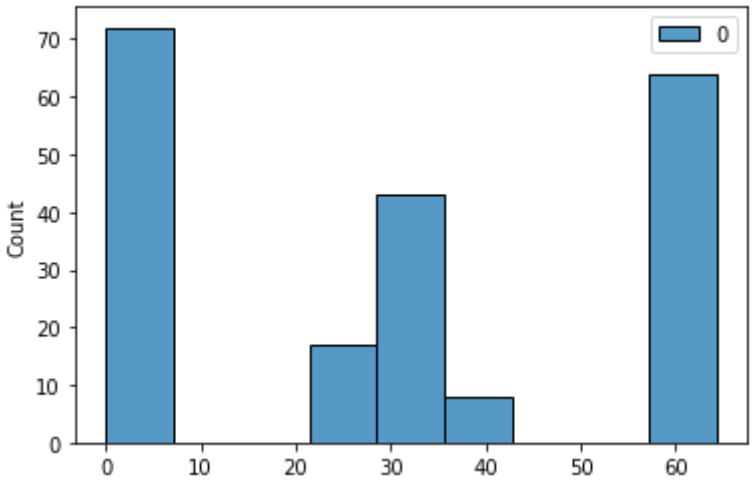
Calymenidae
3



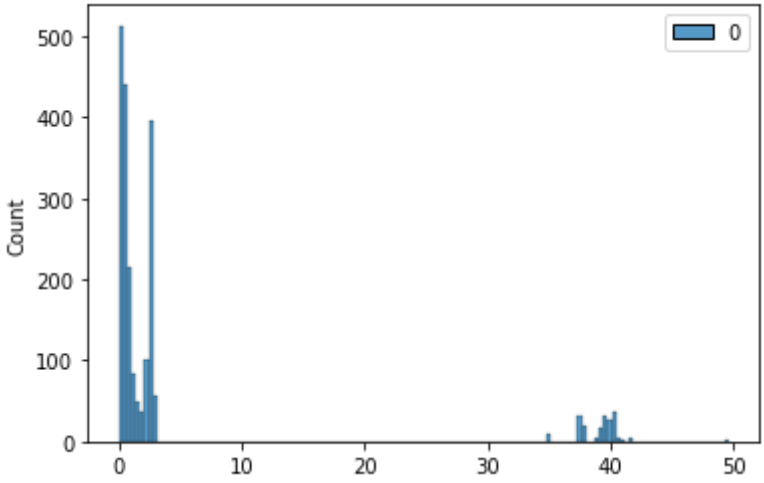
Cheiruridae
1
Dalmanitidae
2



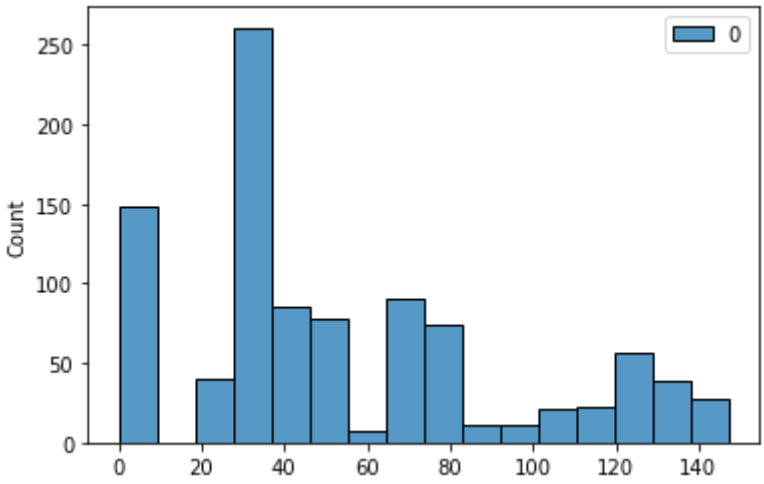
Harpetidae
22



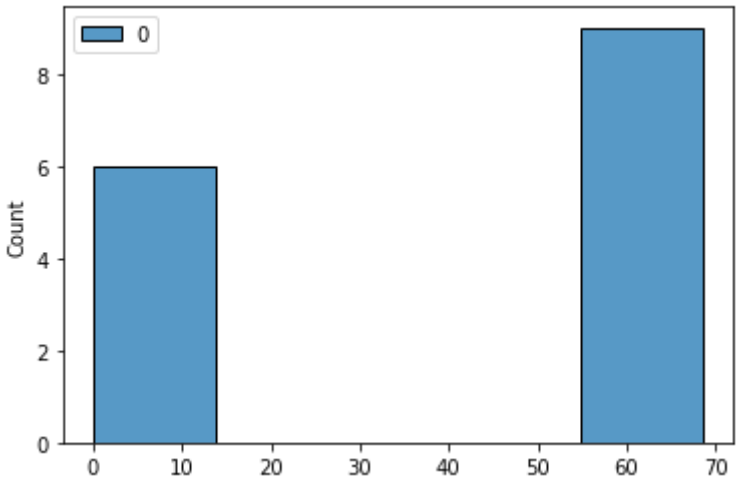
Homalonotidae
65



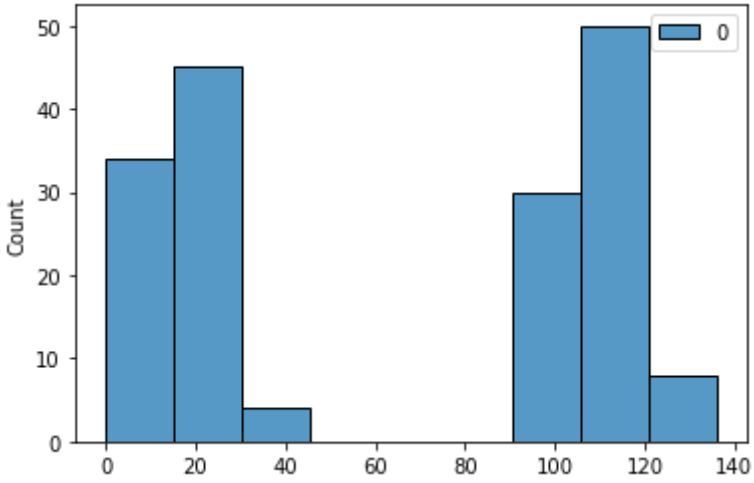
Lichidae
45



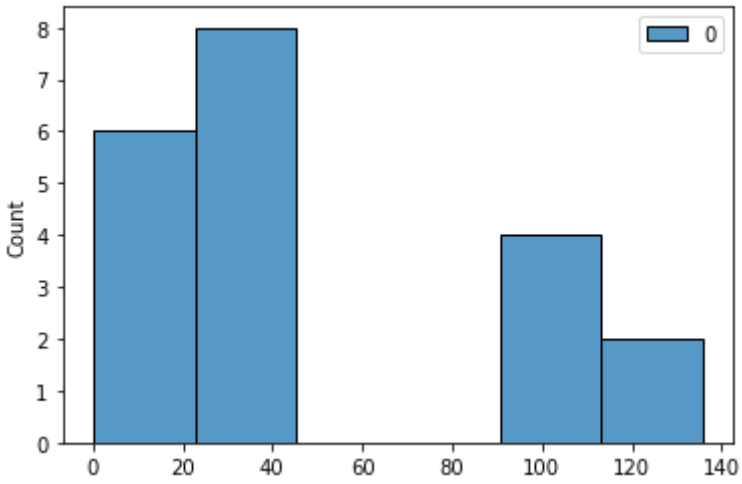
NO_FAMILY_SPECIFIED
6



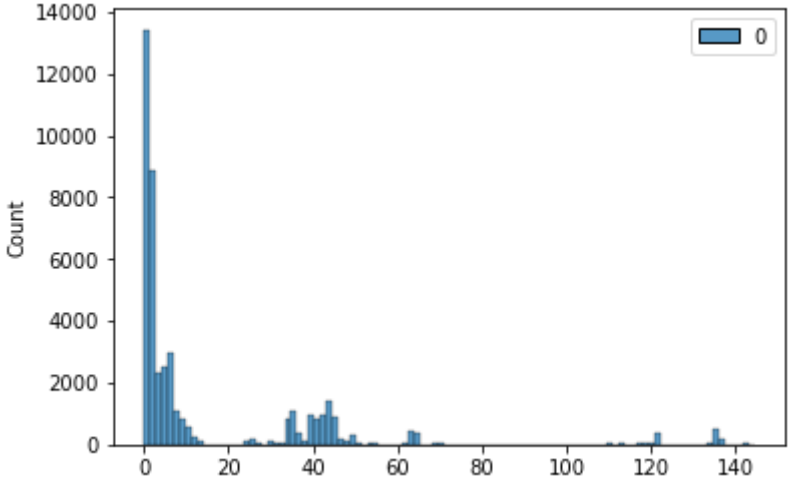
Odontopleuridae
19



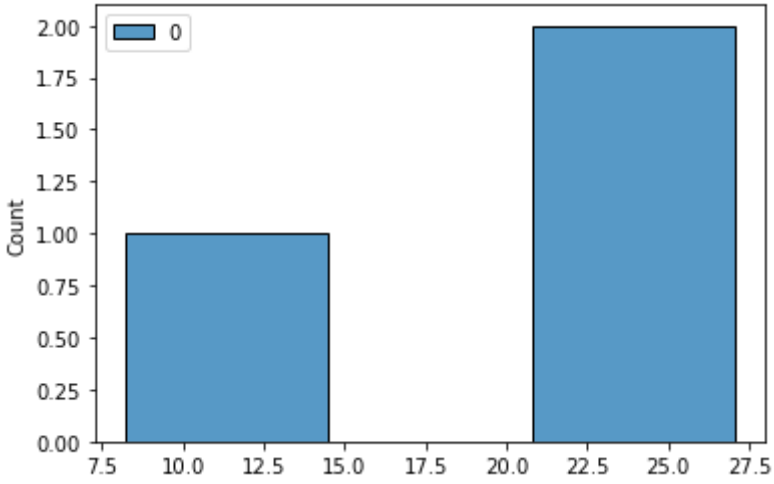
Otarionidae
7



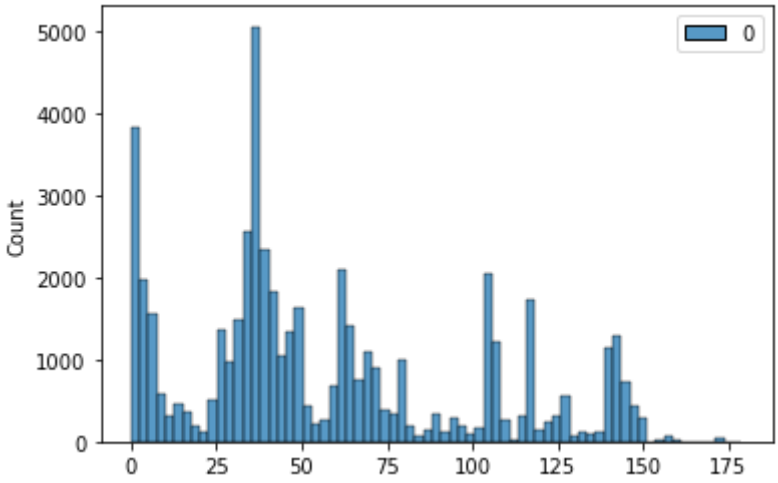
Phacopidae
298



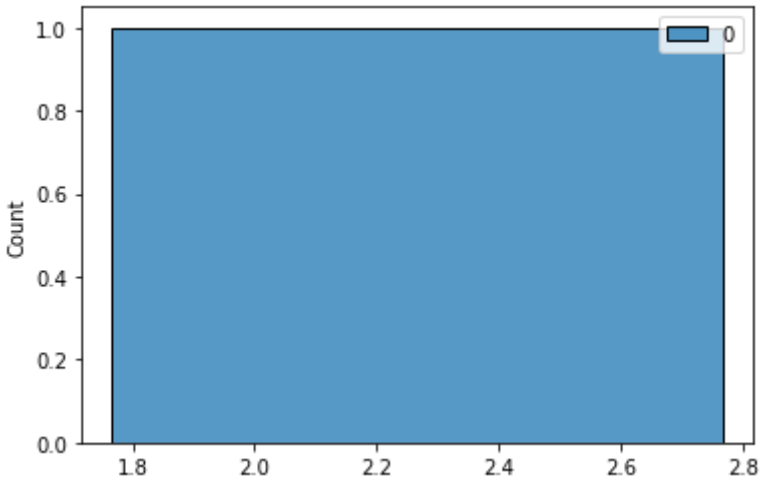
Phillipsiidae
3



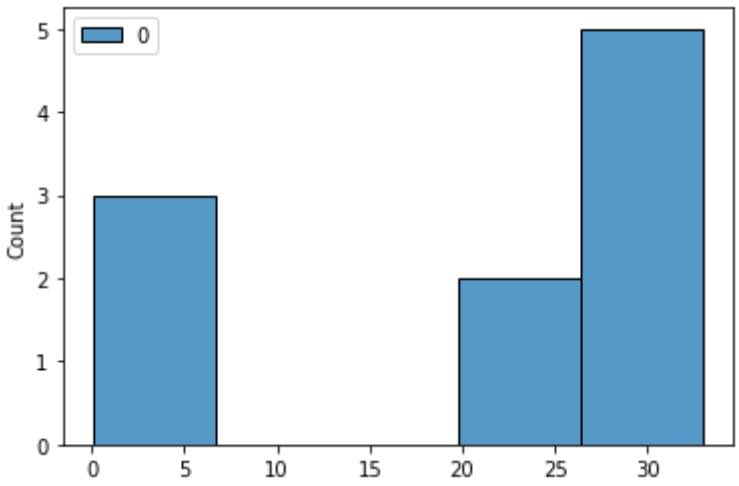
Proetidae
323



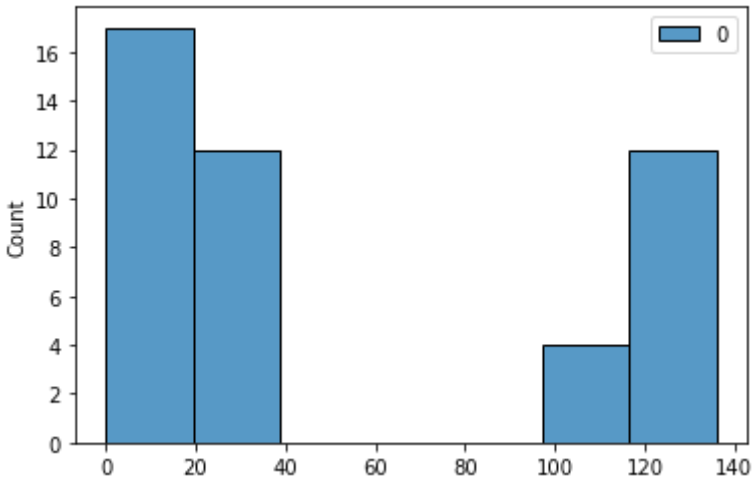
Rorringtoniidae
2



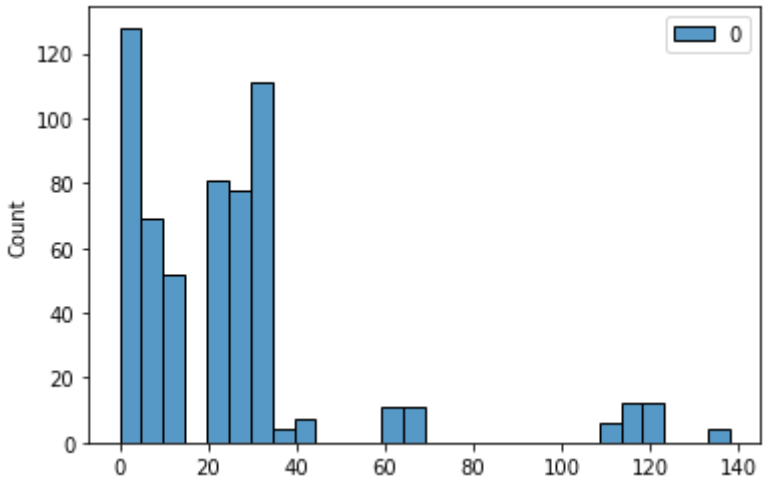
Scharyiidae
5



Styginidae
10



Tropidocoryphidae
35



In [ ]: