Step 5. Summary

- Purpose:
  - For each frame, plot the head and the flagellum using different colors.
  - Plot the head in all frames into one figure.

In [1]:
```
from __future__ import print_function
import SimpleITK as sitk
import numpy as np
import matplotlib.pyplot as plt
import scipy.io as sio
```

In [2]:
```
def DisplayArray(array, title):
    plt.imshow(array, cmap='gray')
    plt.title(title)
    plt.show()
    return
```

Step 5.1 Load the data.

In [3]:
```
sperm = sio.loadmat('../Movie/SpermInfo.mat')
```

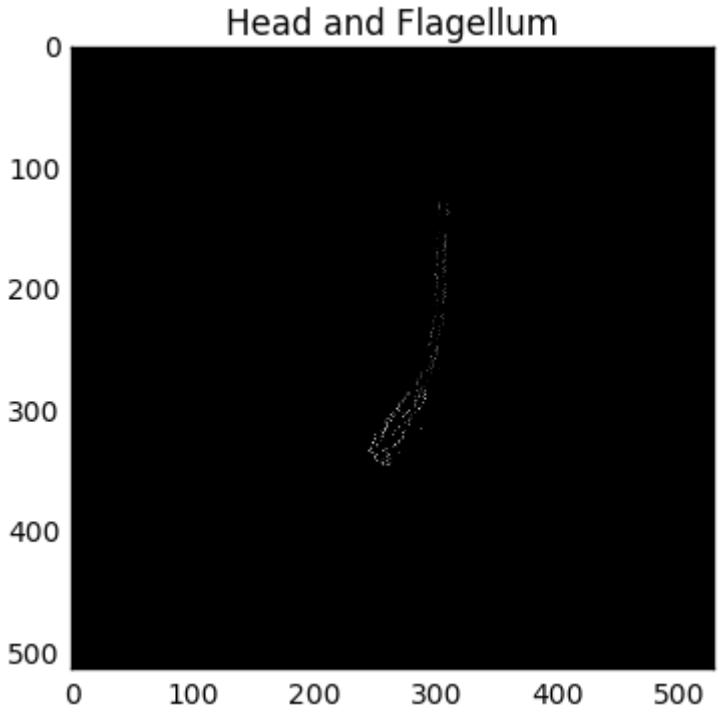
In [4]:
```
# Get the size of the movie.
n1 = sperm['size'][0,0]
n2 = sperm['size'][0,1]
n3 = 20
```

In [5]:
```
# Get information in sperm.
Flagellum = sperm["flagellum"]
Frame = sperm["frames"]
Head = sperm["head"]
```

5.2 Plot the head and the flagellum separately.

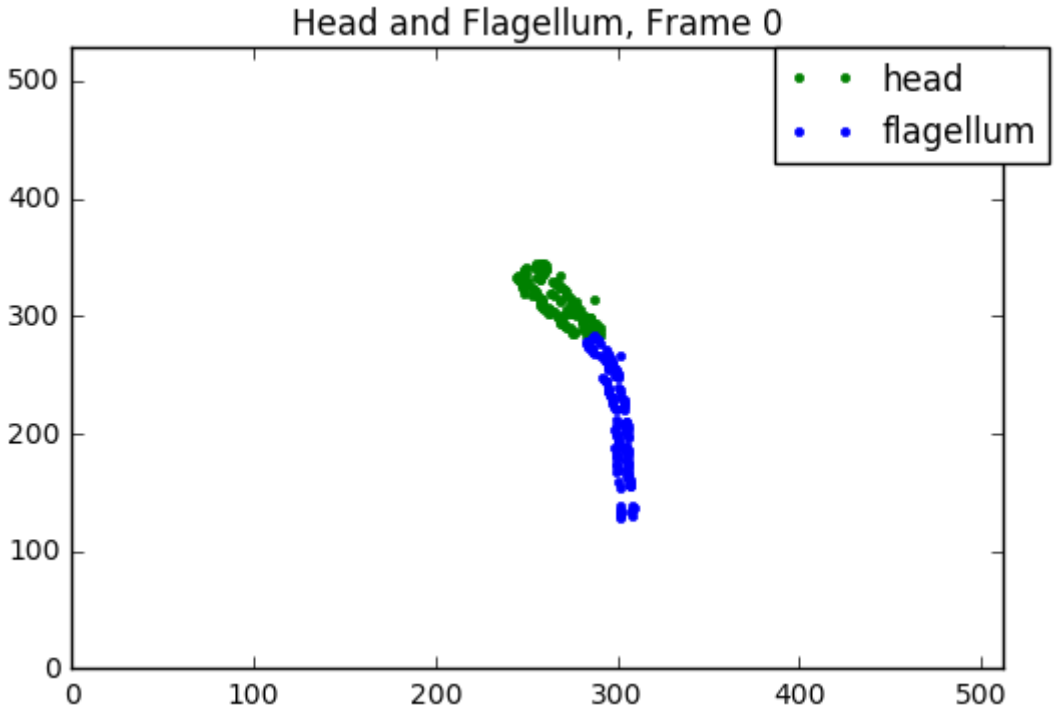
In [6]:
```
newMovie = np.zeros( (n3,n2,n1) )
for k in range(n3):
    if k in Frame:
        # Loop in head.
        head = Head[0,k].astype(int)
        nh1,nh2 = head.shape
        for ii in range(nh1):
            newMovie[k, head[ii,0], head[ii,1] ] = 1
        # Loop in flagellum.
        flagellum = Flagellum[0,k].astype(int)
        nf1,nf2 = flagellum.shape
        for jj in range(nf1):
            newMovie[k, flagellum[jj,0], flagellum[jj,1] ] = 0.5
    # end of if ( k in Frame ) loop on
# end of for loop on k
```

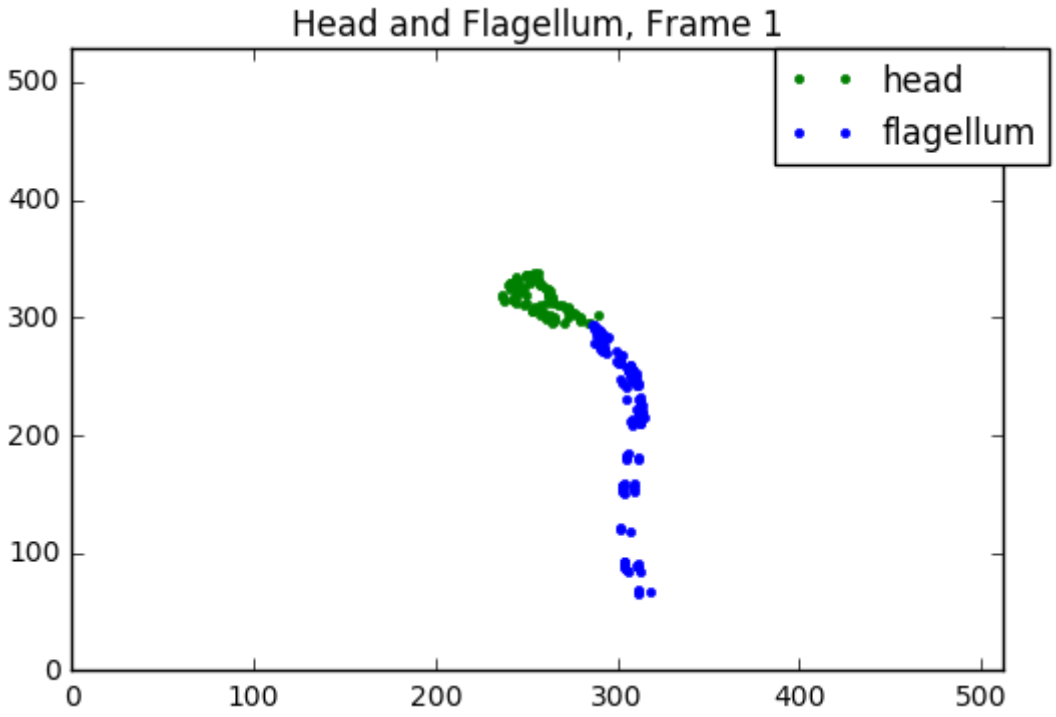
In [7]:
```
# Display one frame as an example.
DisplayArray(newMovie[0,:,:], 'Head and Flagellum')
```

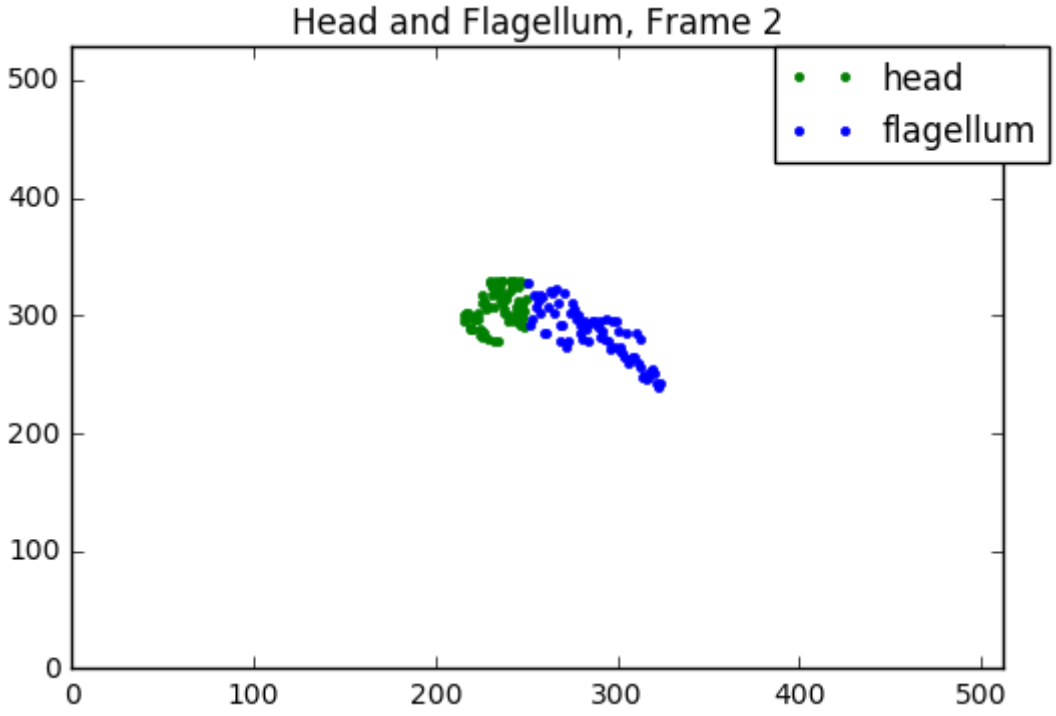


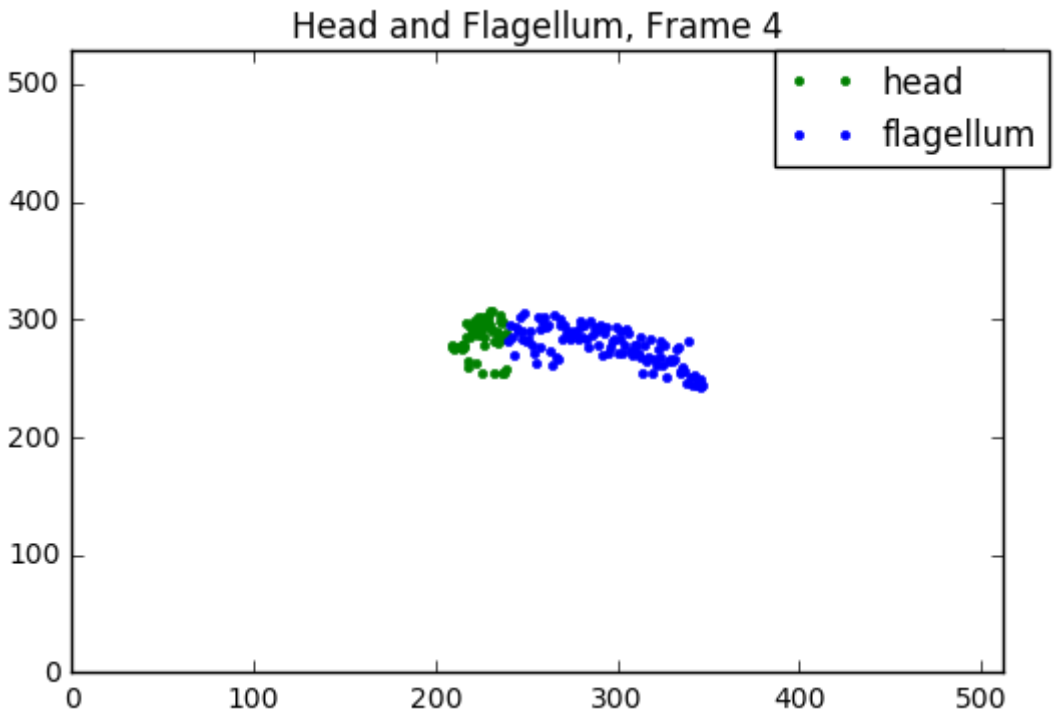
This visualization is not legible. Try another visualization.

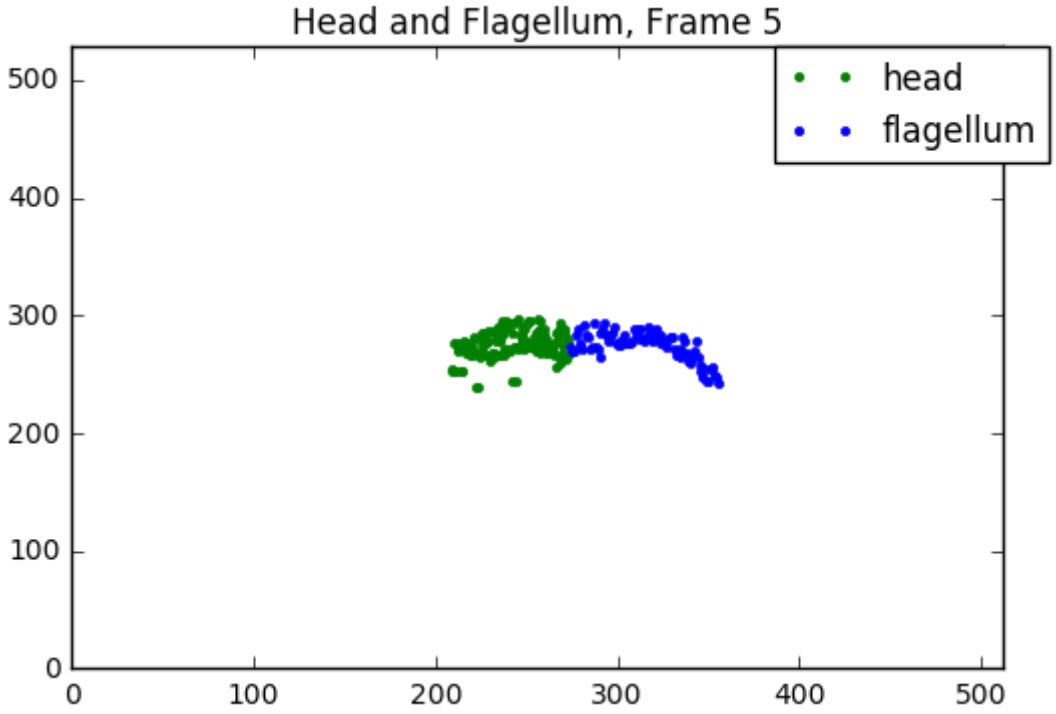
In [8]:
```
for k in range(n3):
    if k in Frame:
        plt.figure()
        head = Head[0,k].astype(int)
        flagellum = Flagellum[0,k].astype(int)
        plt.plot(head[:,1], head[:,0], "g.", label="head")
        plt.plot(flagellum[:,1], flagellum[:,0], "b.", label="flagellum")
        x1,x2,y1,y2 = plt.axis()
        plt.axis((0,n2,0,n1))
        plt.legend(bbox_to_anchor=(1.05, 1), loc=1, borderaxespad=0.)
        plt.title("Head and Flagellum, Frame "+str(k))
        plt.show()
    # end of if ( k in Frame ) loop on
# end of for loop on k
```

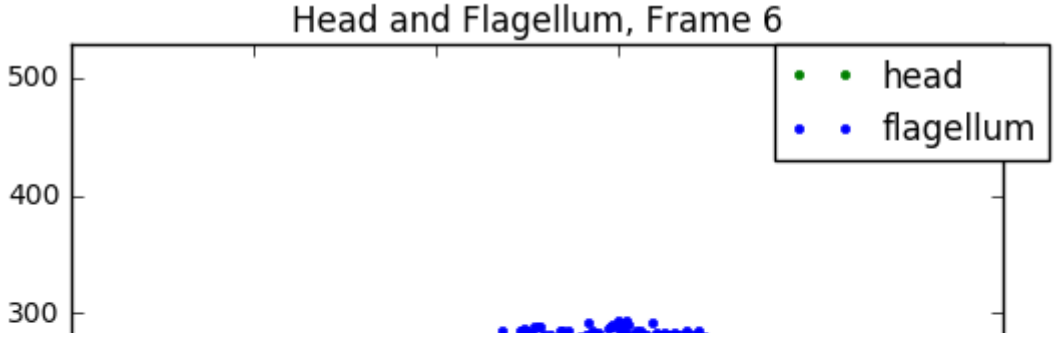


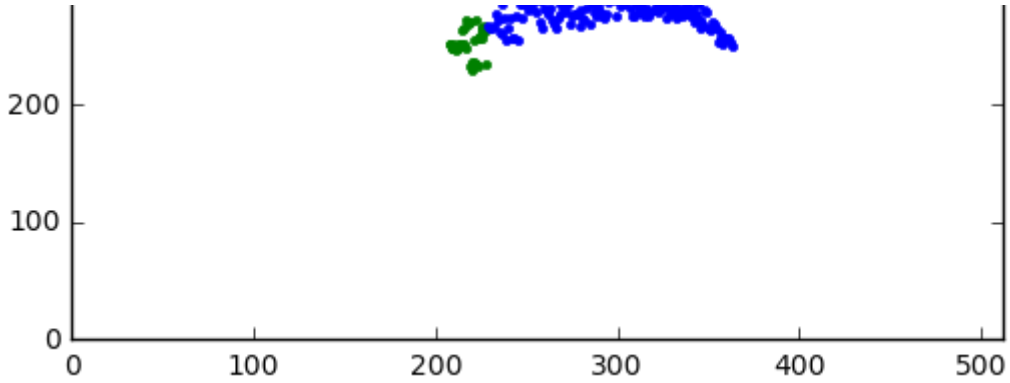

Head and Flagellum, Frame 1
head
flagellum
0
100
200
300
400
500

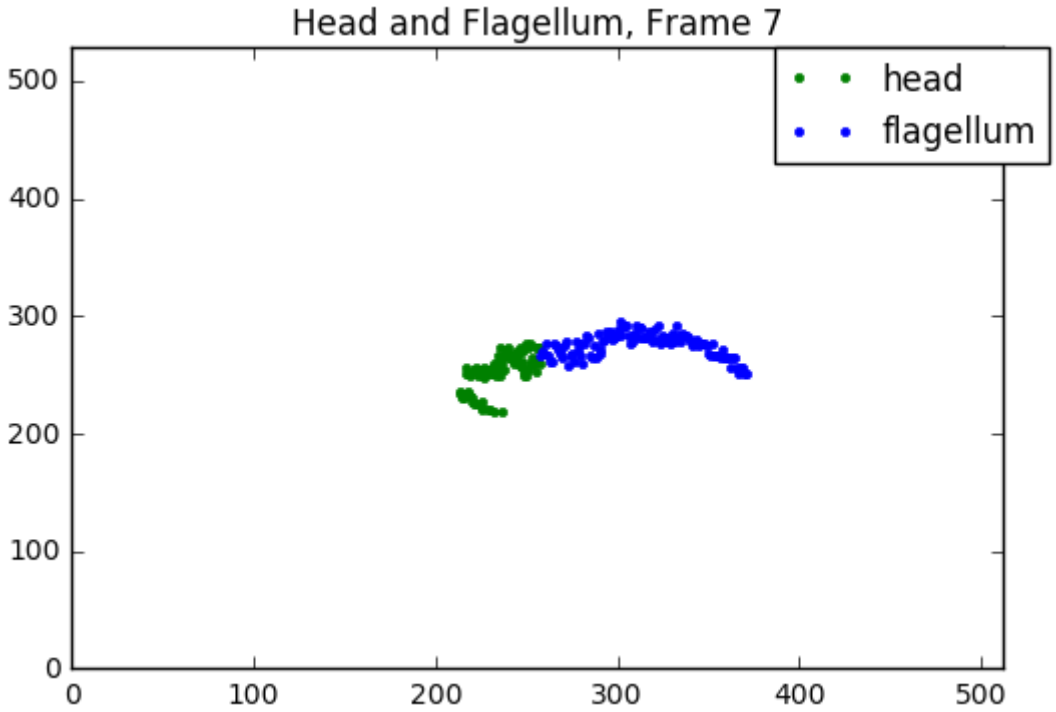

Head and Flagellum, Frame 2
head
flagellum
0
100
200
300
400
500

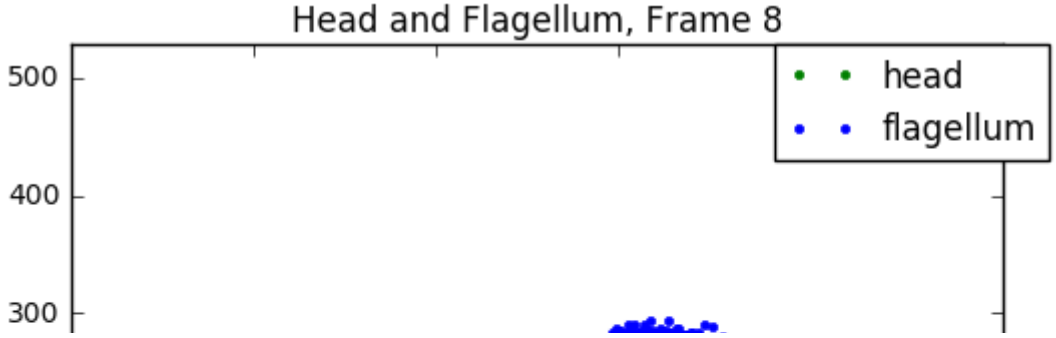

Head and Flagellum, Frame 4
head
flagellum
0
100
200
300
400
500

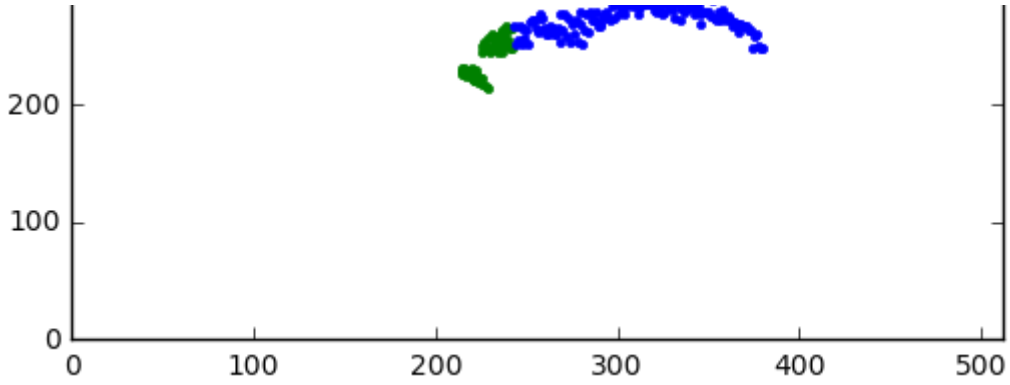

Head and Flagellum, Frame 5
head
flagellum
0
100
200
300
400
500

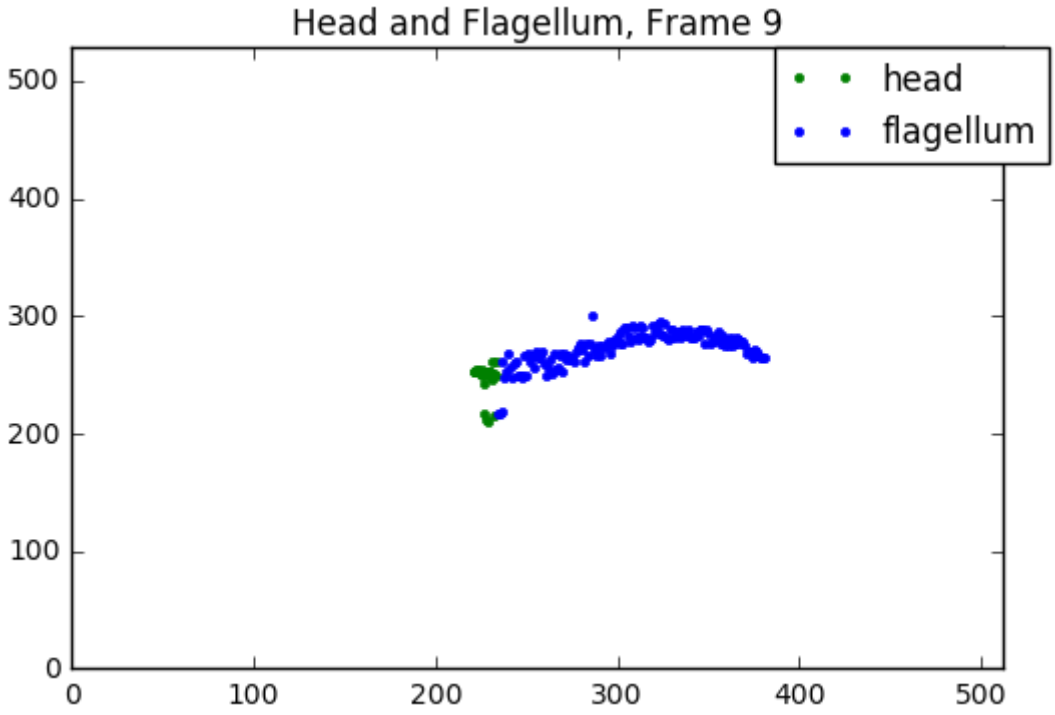

Head and Flagellum, Frame 6
head
flagellum
300
400
500

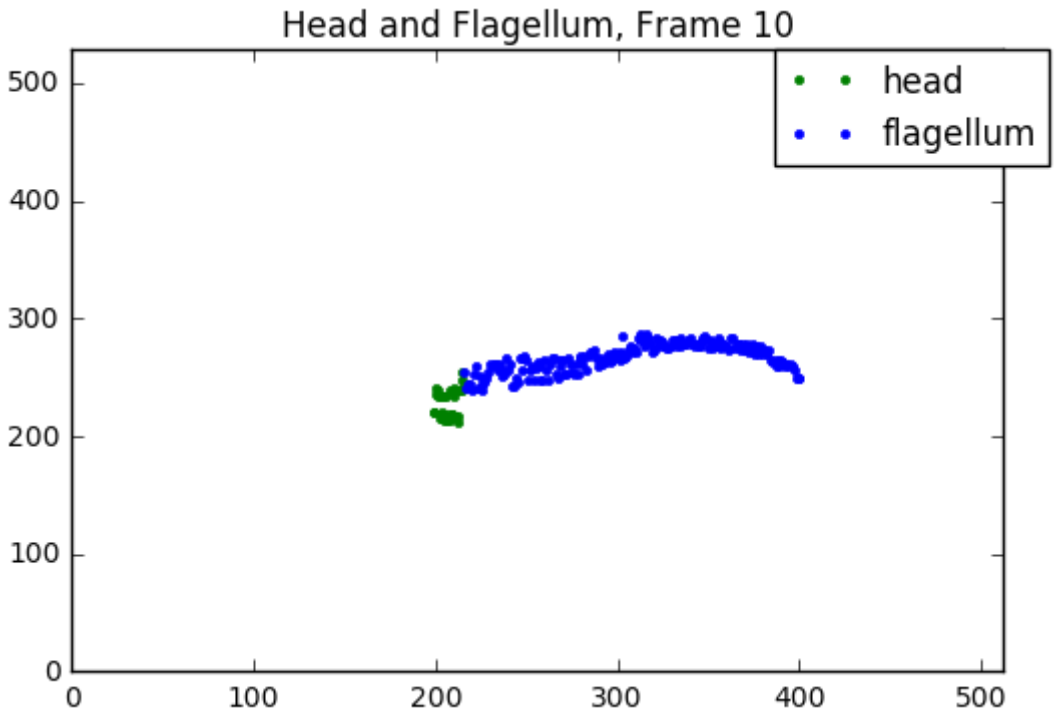

200
100
0
0
100
200
300
400
500

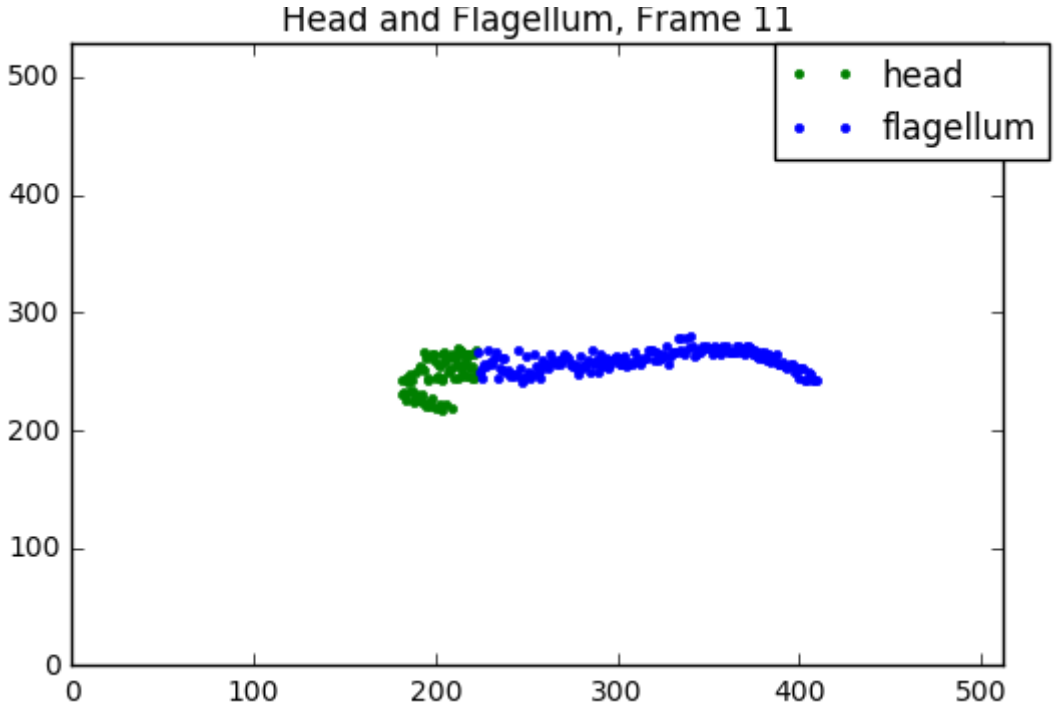

Head and Flagellum, Frame 7
head
flagellum
500
400
300
200
100
0
0
100
200
300
400
500

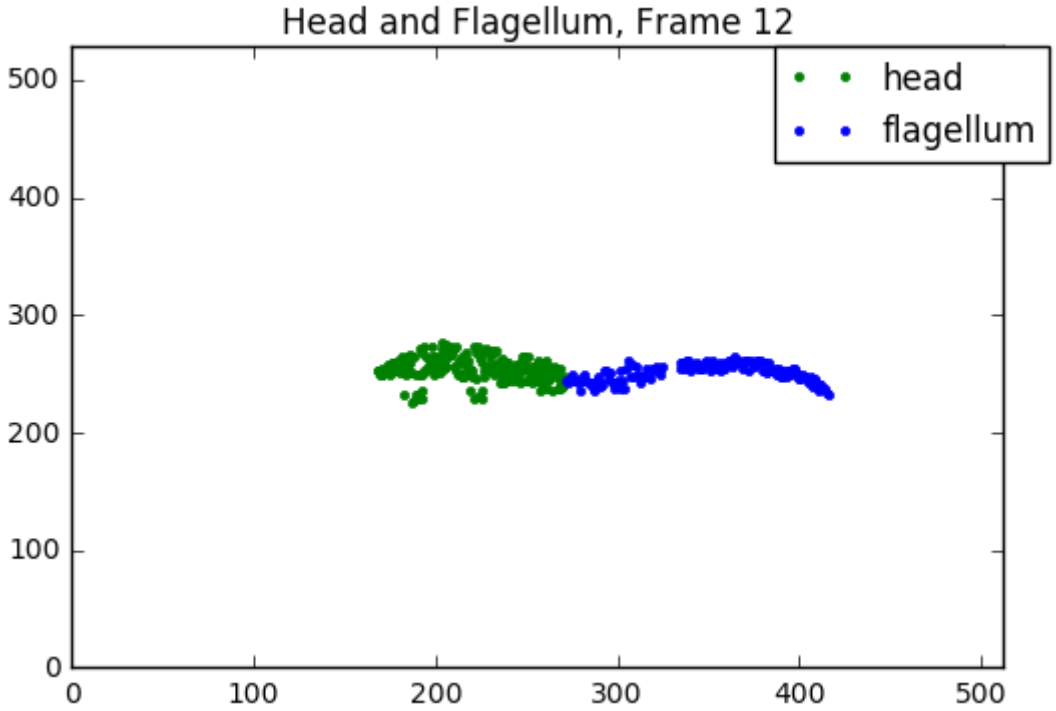

Head and Flagellum, Frame 8
head
flagellum
500
400
300

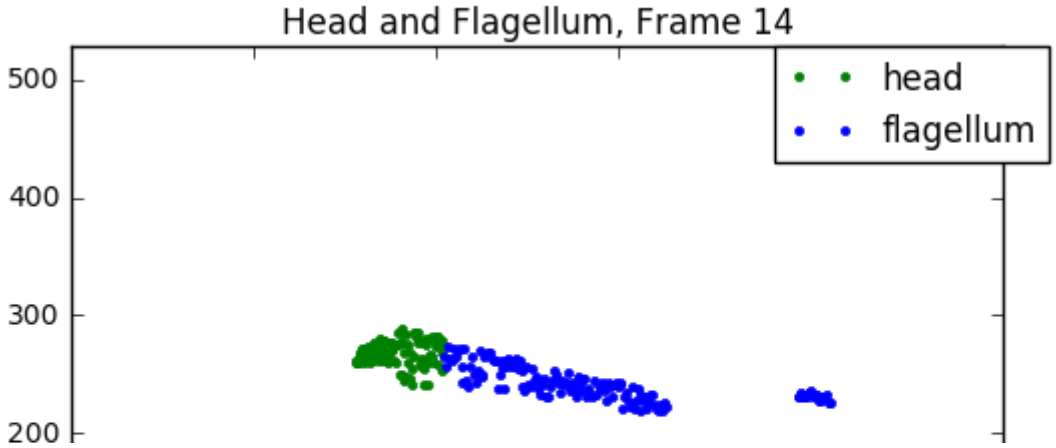

0
100
200
0
100
200
300
400
500

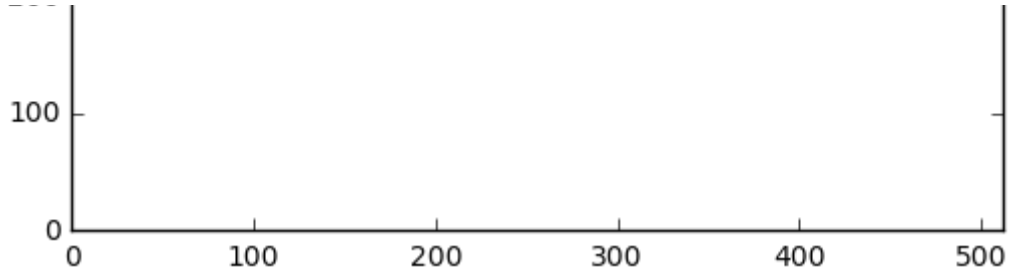

Head and Flagellum, Frame 9
head
flagellum
0
100
200
300
400
500

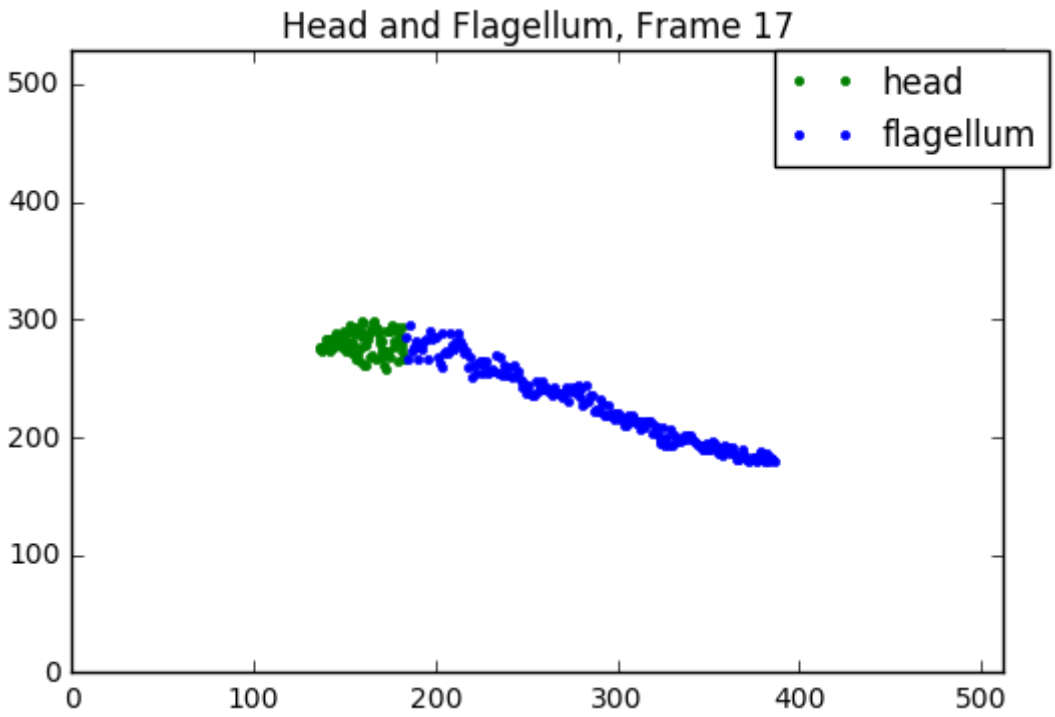

Head and Flagellum, Frame 10
head
flagellum
0
100
200
300
400
500

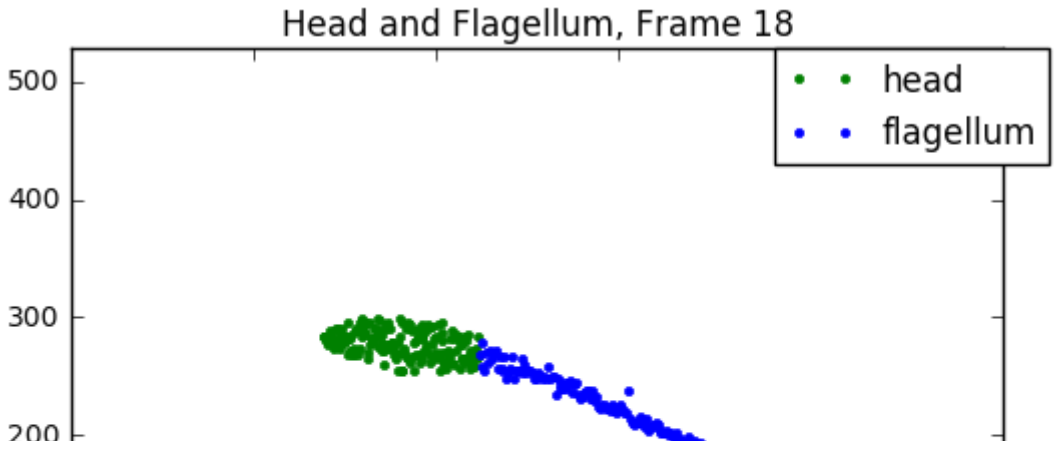

Head and Flagellum, Frame 11
head
flagellum
500
400
300
200
100
0
0
100
200
300
400
500

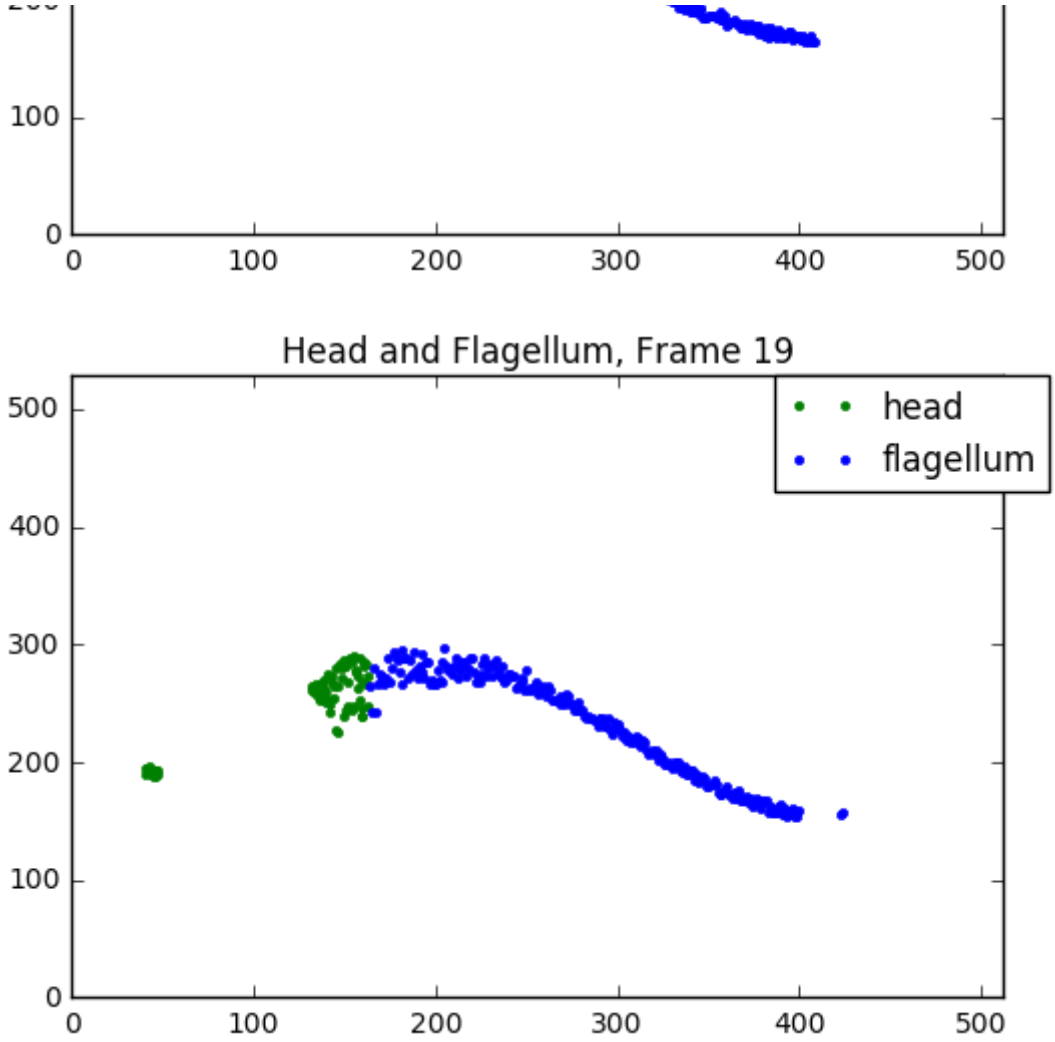

Head and Flagellum, Frame 12
head
flagellum
500
400
300
200
100
0
0
100
200
300
400
500


Head and Flagellum, Frame 14
head
flagellum
500
400
300
200


100
0
0
100
200
300
400
500


Head and Flagellum, Frame 17
head
flagellum
500
400
300
200
100
0
0
100
200
300
400
500

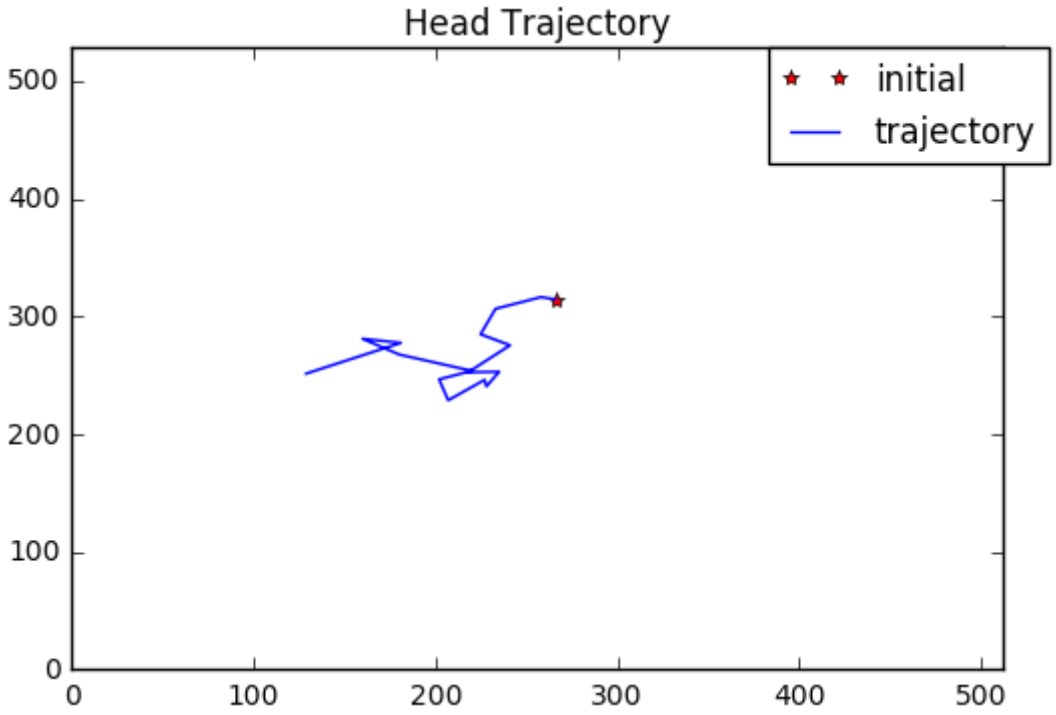

Head and Flagellum, Frame 18
head
flagellum
500
400
300
200



5.3 Plot the head in all frames into one figure.

In [9]:
```
# Center of the head
x = []
y = []
for k in range(0,n3):
    if k in Frame:
        head = Head[0,k].astype(int)
        # Compute the center of the head.
        y.append( np.mean(head[:,0]) )
        x.append( np.mean(head[:,1]) )
```

In [10]:
```
plt.figure()
plt.plot(x[0], y[0], "r*", label="initial")
plt.plot(x, y, "b-", label="trajectory")
x1,x2,y1,y2 = plt.axis()
plt.axis((0,n2,0,n1))
plt.legend(bbox_to_anchor=(1.05, 1), loc=1, borderaxespad=0.)
plt.title("Head Trajectory")
plt.show()
```



In [11]:
```
plt.figure()
plt.plot(x[0], y[0], "r*", label="initial")
plt.plot(x, y, "b-", label="trajectory")
x1,x2,y1,y2 = plt.axis()
plt.axis((0,n2,0,n1))
plt.legend(bbox_to_anchor=(1.05, 1), loc=1, borderaxespad=0.)
plt.title("Head Trajectory")
plt.savefig( "HeadTrajectory.png" )
```

5.4 Conclusion.

Separating head and flagellum

- Advantage: This algorithm is relatively simple.
- Disadvantage: As discussed in Step04, this algorithm relies on the fact that a decent amount of flagellum is segmented and the fact that the segmentation result is almost perfect for the head. This algorithm is too simple to obtain a high accuracy.

In [ ]: