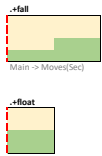


Manipulative Actions				Objects role				Semantic Event chain analysis and motion primitives				Notes																	
	Manipulator	Tool		Main	Primary	Main Support	Secondary	Contact between																					
1.1	Push to break	claw claw claw	- - -	organism fragment fragment	substrate organism organism	water water water	substrate substrate organism	<table><tr><td>R Manipulator</td><td>Main</td><td></td><td></td></tr><tr><td>R Main</td><td>Primary</td><td></td><td></td></tr><tr><td>R Main</td><td>Secondary</td><td></td><td></td></tr><tr><td>R Main</td><td>Main Support</td><td></td><td></td></tr></table> <div>Manip -> Moves(Main) Manip -> Preshape Manip -> ExertForce(Main)</div> <div>Manip -> Moves(home) Main -> Float(Main support)</div>	R Manipulator	Main			R Main	Primary			R Main	Secondary			R Main	Main Support							
R Manipulator	Main																												
R Main	Primary																												
R Main	Secondary																												
R Main	Main Support																												
2	Scrape	claw claw claw	- - -	organism fragment fragment	substrate organism organism	water water water	substrate substrate organism	<table><tr><td>R Manip</td><td>Main</td><td></td><td></td></tr><tr><td>R Main</td><td>Pri</td><td></td><td></td></tr><tr><td>R Main</td><td>Sec</td><td></td><td></td></tr><tr><td>R Main</td><td>M_support</td><td></td><td></td></tr></table> <div>Manip -> Moves(Main) Manip -> Preshape Manip -> ExertForce(Main) Manip -> Surfacefollowing(Primary)</div> <div>Manip -> Moves(home) Main -> Float(Main support)</div>	R Manip	Main			R Main	Pri			R Main	Sec			R Main	M_support							
R Manip	Main																												
R Main	Pri																												
R Main	Sec																												
R Main	M_support																												
2.A	Scrape with tool	claw claw claw claw	suction sampler suction sampler scoop basket	organism fragment organism fragment	substrate organism substrate organism	water water water water	substrate organism substrate basket	<table><tr><td>R Manip</td><td>Tool</td><td>Main</td><td></td></tr><tr><td>R Tool</td><td>Main</td><td></td><td></td></tr><tr><td>R Main</td><td>Pri</td><td></td><td></td></tr><tr><td>R Main</td><td>Sec</td><td></td><td></td></tr><tr><td>R Main</td><td>M_support</td><td></td><td></td></tr></table> <div>Manip -> Moves(Tool) Manip -> Preshape Manip -> Grasp(Tool)</div> <div>Manip -> Moves(Main) Manip -> ExertForce(Main) Manip -> Surfacefollowing(Primary)</div> <div>Manip -> Moves(home) Main -> Float(Main support)</div>	R Manip	Tool	Main		R Tool	Main			R Main	Pri			R Main	Sec			R Main	M_support			
R Manip	Tool	Main																											
R Tool	Main																												
R Main	Pri																												
R Main	Sec																												
R Main	M_support																												
3	Scoop	Victor claw	-	organism and substrate	substrate	water		<table><tr><td>R Manip</td><td>Main</td><td></td><td></td></tr><tr><td>R Main</td><td>Pri</td><td></td><td></td></tr><tr><td>R Main</td><td>Sec</td><td></td><td></td></tr><tr><td>R Main</td><td>M_support</td><td></td><td></td></tr></table> <div>Manip -> Moves(Main) Manip -> Preshape Manip -> Exert force(Main, Primary)</div> <div>Manip -> Turn Manip -> Pull(home)</div>	R Manip	Main			R Main	Pri			R Main	Sec			R Main	M_support							
R Manip	Main																												
R Main	Pri																												
R Main	Sec																												
R Main	M_support																												
3.A.1	Scoop with tool	claw	scoop	organism, substrate	substrate	water		<table><tr><td>R Manip</td><td>Tool</td><td>Main</td><td></td></tr><tr><td>R Tool</td><td>Main</td><td></td><td></td></tr><tr><td>R Main</td><td>Pri</td><td></td><td></td></tr><tr><td>R Main</td><td>Sec</td><td></td><td></td></tr><tr><td>R Main</td><td>M_support</td><td></td><td></td></tr></table> <div>Manip -> Moves(Tool) Manip -> Preshape Manip -> Grasp(Tool)</div> <div>Manip -> Moves(Main) Manip -> Preshape Manip -> Exert force (Main, Primary)</div> <div>Manip -> Turn Manip -> Pull(home)</div>	R Manip	Tool	Main		R Tool	Main			R Main	Pri			R Main	Sec			R Main	M_support			
R Manip	Tool	Main																											
R Tool	Main																												
R Main	Pri																												
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R Main	M_support																												
3.A.1	Scoop with tool	claw	scoop net	organism, substrate	substrate	water	scoop net	<table><tr><td>R Manip</td><td>Tool</td><td>Main</td><td></td></tr><tr><td>R Tool</td><td>Main</td><td></td><td></td></tr><tr><td>R Main</td><td>Pri</td><td></td><td></td></tr><tr><td>R Main</td><td>Sec</td><td></td><td></td></tr><tr><td>R Main</td><td>M_support</td><td></td><td></td></tr></table> <div>Manip -> Moves(Tool) Manip -> Preshape Manip -> Grasp(Tool)</div> <div>Manip -> Moves(Main) Manip -> Preshape Manip -> Exert force (Main, Primary)</div> <div>Manip -> Turn Manip -> Pull(home)</div>	R Manip	Tool	Main		R Tool	Main			R Main	Pri			R Main	Sec			R Main	M_support			
R Manip	Tool	Main																											
R Tool	Main																												
R Main	Pri																												
R Main	Sec																												
R Main	M_support																												
4.A	Core with corer	claw	corer	organism, substrate	substrate	water	corer	<table><tr><td>R Manip</td><td>Tool</td><td>Main</td><td></td></tr><tr><td>R Tool</td><td>Main</td><td></td><td></td></tr><tr><td>R Main</td><td>Pri</td><td></td><td></td></tr><tr><td>R Main</td><td>Sec</td><td></td><td></td></tr><tr><td>R Main</td><td>M_support</td><td></td><td></td></tr></table> <div>Manip -> Moves(Tool) Manip -> Preshape Manip -> Grasp(Tool)</div> <div>Manip -> Moves(Main) Manip -> Preshape Manip -> Exert force (Main, Primary)</div> <div>Manip -> Pull(home)</div>	R Manip	Tool	Main		R Tool	Main			R Main	Pri			R Main	Sec			R Main	M_support			
R Manip	Tool	Main																											
R Tool	Main																												
R Main	Pri																												
R Main	Sec																												
R Main	M_support																												
5	Grip	claw claw	- -	organism fragment	substrate, water, organism substrate, water, organism	water water		<table><tr><td>R Manip</td><td>Main</td><td></td><td></td></tr><tr><td>R Main</td><td>Pri</td><td></td><td></td></tr><tr><td>R Main</td><td>Sec</td><td></td><td></td></tr><tr><td>R Main</td><td>M_support</td><td></td><td></td></tr></table> <div>Manip -> Moves(Main) Manip -> Preshape Manip -> Grasp (Main)</div> <div>Manip -> Moves(home)</div>	R Manip	Main			R Main	Pri			R Main	Sec			R Main	M_support							
R Manip	Main																												
R Main	Pri																												
R Main	Sec																												
R Main	M_support																												
5.1	Grip and twist	claw	-	organism	substrate	water		<table><tr><td>R Manip</td><td>Main</td><td></td><td></td></tr><tr><td>R Main</td><td>Pri</td><td></td><td></td></tr><tr><td>R Main</td><td>Sec</td><td></td><td></td></tr><tr><td>R Main</td><td>M_support</td><td></td><td></td></tr></table> <div>Manip -> Moves(Main) Manip -> Preshape Manip -> Grasp (Main)</div> <div>Manip -> Twist</div>	R Manip	Main			R Main	Pri			R Main	Sec			R Main	M_support							
R Manip	Main																												
R Main	Pri																												
R Main	Sec																												
R Main	M_support																												
5.2	Grip and pull	claw	-	organism	substrate	water		<table><tr><td>R Manip</td><td>Main</td><td></td><td></td></tr><tr><td>R Main</td><td>Pri</td><td></td><td></td></tr><tr><td>R Main</td><td>Sec</td><td></td><td></td></tr><tr><td>R Main</td><td>M_support</td><td></td><td></td></tr></table> <div>Manip -> Moves(Main) Manip -> Preshape Manip -> Grasp (Main)</div> <div>Manip -> Pull(home)</div>	R Manip	Main			R Main	Pri			R Main	Sec			R Main	M_support							
R Manip	Main																												
R Main	Pri																												
R Main	Sec																												
R Main	M_support																												
5.B	Grip tool	claw	-	trap	substrate	water		<table><tr><td>R Manip</td><td>Main</td><td></td><td></td></tr><tr><td>R Main</td><td>Pri</td><td></td><td></td></tr><tr><td>R Main</td><td>Sec</td><td></td><td></td></tr><tr><td>R Main</td><td>M_support</td><td></td><td></td></tr></table> <div>Manip -> Moves(Main) Manip -> Preshape Manip -> Grasp (Main)</div> <div>Manip -> Moves(home)</div>	R Manip	Main			R Main	Pri			R Main	Sec			R Main	M_support							
R Manip	Main																												
R Main	Pri																												
R Main	Sec																												
R Main	M_support																												
6	Cage	Liropus claw Victor claw	- -	organism, substrate organism, substrate	substrate substrate	water water		<table><tr><td>R Manip</td><td>Main</td><td></td><td></td></tr><tr><td>R Main</td><td>Pri</td><td></td><td></td></tr><tr><td>R Main</td><td>Sec</td><td></td><td></td></tr><tr><td>R Main</td><td>M_support</td><td></td><td></td></tr></table> <div>Manip -> Moves(Main) Manip -> Preshape Manip -> Envelop (Main)</div> <div>Manip -> Pull(home)</div>	R Manip	Main			R Main	Pri			R Main	Sec			R Main	M_support							
R Manip	Main																												
R Main	Pri																												
R Main	Sec																												
R Main	M_support																												



Task	Tool	Object	Material	Environment	Robot Configuration	Action Sequence
6.1 Cage and pull	Liropus claw Victor claw	- -	organism, substrate organism, substrate	substrate substrate	water water	<p>R Manip Main R Main Pri R Main Sec R Main M_support</p> <p>Manip -> Moves(Main) Manip -> Pull(home)</p>
7.A Suction on with SS	claw claw	suction sampler with sieve suction sampler with sieve	organism fragment	substrate, water, organism substrate, water, organism	water water	<p>R Manip Tool R Tool Main R Main Pri R Main Sec R Main M_support</p> <p>Manip -> Preshape Manip -> Envelop(Main) Manip -> Moves(Main) Manip -> Turn on suction</p>
8.A Suction and store	claw claw	suction sampler suction sampler	organism fragment	substrate, water, organism substrate, water, organism	water jar	<p>R Manip Tool R Tool Main R Main Pri R Main Sec R Main M_support</p> <p>Manip -> Moves(Main) Manip -> Turn on suction Manip -> Moves(jar)</p>
9.A Suction off with SS						<p>R Manip Tool R Tool Main R Main Pri R Main Sec R Main M_support</p> <p>Manip -> Moves(Secondary) Manip -> Turn off suction Main -> Float(Main support)</p>
10 Release						<p>R Manip Main R Main Pri R Main Sec R Main M_support</p> <p>Manip -> Moves(Sec) Manip -> Release Main -> Float(Main support)</p>
10.B Release tool	claw claw	- -	scoop net corer	claw claw	water water	<p>R Manip Main R Main Pri R Main Sec R Main M_support</p> <p>Manip -> Moves(Secondary) Manip -> Insert(Secondary) Manip -> Release Main -> Fall(Secondary)</p>
11 Pour						<p>R Manip Main R Main Pri R Main Sec R Main M_support</p> <p>Manip -> Moves(Secondary) Manip -> Turn Main -> Fall(Secondary)</p>
11.A Pour with tool						<p>R Manip Tool R Tool Main R Main Pri R Main Sec R Main M_support</p> <p>Manip -> Moves(Sec) Manip -> Turn Main -> Fall(Secondary)</p>
12 Scissor Cut						
11 Hook						
12 Lever						